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PALYNOLOGICAL CORRELATION OF LATE CRETACEOUS BEDS, SHEERNESS, ALBERTA

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

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DEPARTMENT OF GEOLOGY

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FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Palynological Correlation of Late Cretaceous Beds, Sheerness, Alberta", by Gerhard Bihl, B.Sc., in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

Palynological data obtained from an outcrop section show that lower Edmonton sediments are exposed near Sheerness. These strata may be correlated with beds approximately 200 feet below the Drumheller Marine Tongue of the Edmonton Formation of the Drumheller area. Thirty two species of fossil pollen belonging to seventeen genera of dicotyledonous affinity are described and illustrated from the Sheerness badlands. Genera described include: *Ailanthipites*, *Alnipollenites*, *Aquilapollenites*, *Beaupreaidites*, *Callistopollenites*, *Coriaripites*, *Cranwellia*, *Erdtmanipollis*, *Fraxinoipollenites*, *Ilexpollenites*, *Liquidambarpollenites*, *Mancicorpus*, *Mtchedlishvilia*, *Orbiculapollis*, *Proteacidites*, *Pulcheripollenites*, and *Quercoidites*.

ACKNOWLEDGEMENTS

The writer wishes to express his gratefulness to Professor C.R. Stelck for his guidance and encouragement during the critical stages of the writer's work. Thanks are owing to Dr. S.K. Srivastava whose advice was invaluable. Without his collection of comparative palynological slides and extensive library of rare pertinent literature, this work could not have been completed so quickly.

Mr. F. Dimitrov reproduced the plates. Mrs. Sheila Savage typed the final manuscript and the writer's wife, Sandra Bihl, assisted in linguistic corrections and typed all preliminary manuscripts.

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CHAPTER ONE

INTRODUCTION

Preamble

Dr. J.A. Allan (1935) investigated the geology of the Sheerness coal-basin in east central Alberta and observed that "....the strata in the Edmonton Formation rise to the east and it is the lower part of the series that occurs at the surface east of the Hand Hills." There are 14 coal seams in the whole of the Edmonton Formation and Allan suggested that the coal seam being mined at Sheerness might be correlated with the No. 1 seam* at Drumheller which in that area is the lowest commercial coal seam of the Edmonton Formation. No. 1 seam occurs 75 to 90 feet above the Bearpaw Formation at Rosedale about 36 miles south-west of Sheerness and 10 miles south-east of Drumheller.

On the basis of a study of microfloral zones Dr. J.D. Campbell (1962) proposed the conclusion that the Kneehills Tuff Member at the top of the middle division of the Edmonton Formation rests directly and conformably on sediments of the Bearpaw Formation at Sheerness. He indicates that "....the Kneehills Tuff Member is separated from the underlying Bearpaw Formation by a thin lensy coal interval...." probably corresponding to Allan's No. 1 seam. The Kneehills Tuff, according to

* The coal seams are numbered from No. 1 at the bottom to No. 14 at the top.

MAP OF THE SHEERNESS BADLANDS (13-22-29-13W4)

FIG. 1

FIG. 2

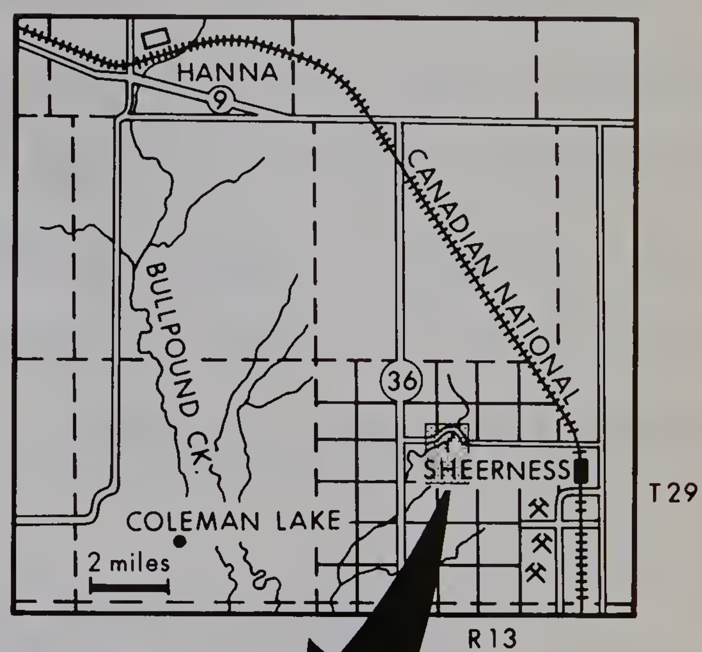
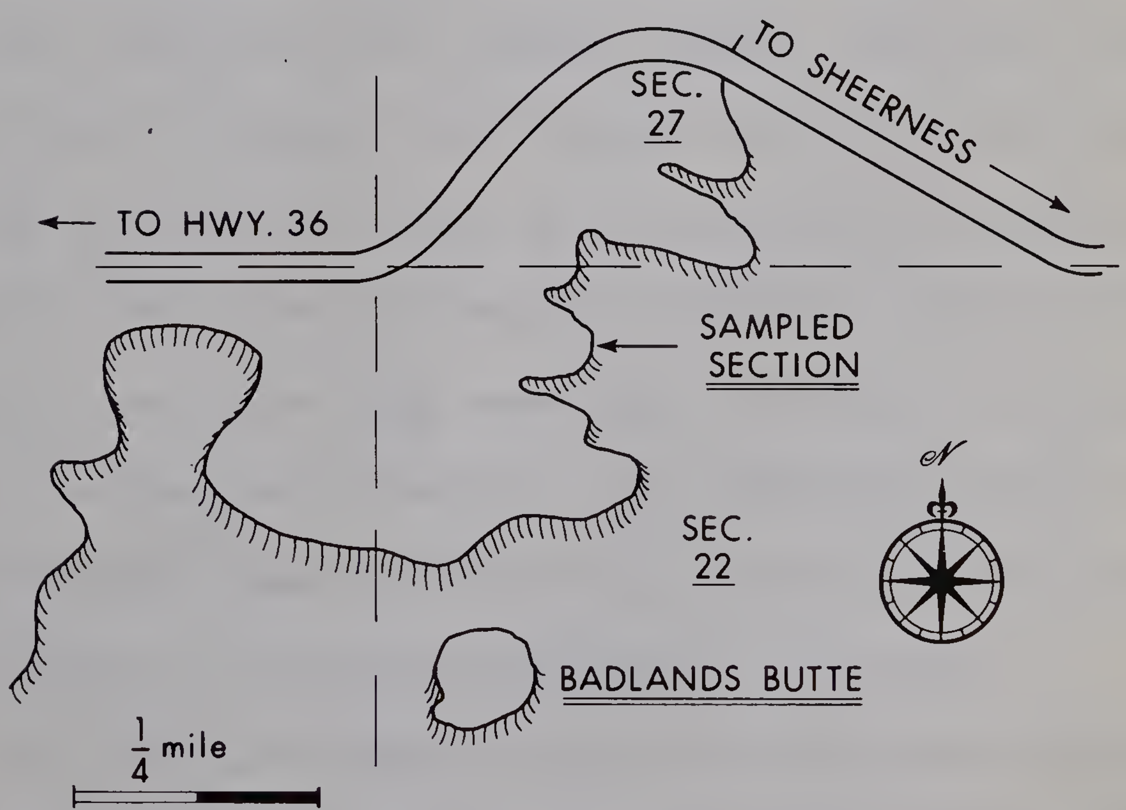


FIG. 3



Campbell, is exposed in a badland area about three miles due west of Sheerness above a zone of white sandstone in a mauve shale beneath a chocolate brown shale. A study of the palynology of these badlands was undertaken by the writer to determine whether the strata at Sheerness above the coal mined there, belong to the lowermost Edmonton Formation or are to be placed above the Drumheller Marine Tongue and therefore belong to the middle Edmonton Formation. The study was to determine also whether the chocolate brown shale at the top of the Sheerness badlands section was actually a portion of the upper Edmonton Formation.

Pertinent Previous Work on the Edmonton Formation

Selwyn (1873-74) introduced the term "Edmonton" for Upper Cretaceous coal-bearing strata along the North Saskatchewan River near Edmonton city. Tyrrell (1886) correlated these beds with sections of similar beds exposed along the Red Deer River. Using the occurrence of coal as a criterion he included all continental beds from the marine (Bearpaw) shales below, to the top of the Ardley coal seam which is above the Kneehills Tuff in his Edmonton Formation. The underlying marine Bearpaw beds were first named by Hatcher and Stanton (1903) after a type locality in the Bearpaw mountains in Montana.

By 1945 an intensive study of the Edmonton Formation on the Red Deer River was summarized by Allan and Sanderson who proposed a three-fold division of this formation. The lower

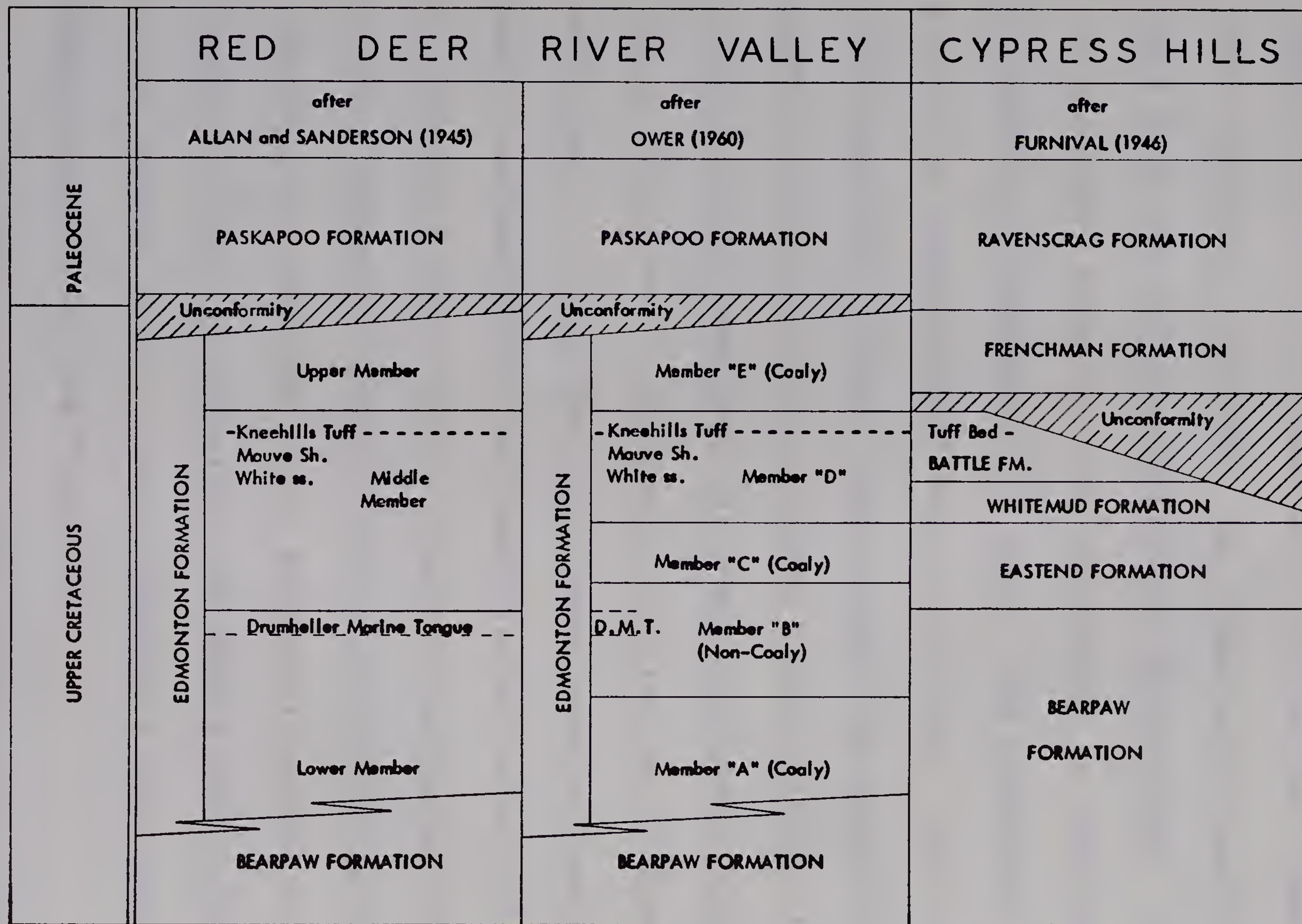


Figure 4: Stratigraphic correlation of the Edmonton Formation with the Upper Cretaceous strata of the Cypress Hills area (after J.D. Campbell, 1962).

Edmonton division was designated as the interval from the Bearpaw shale to the top of the Drumheller Marine Tongue, the Middle Edmonton division from above the Drumheller Marine Tongue to the Kneehills Tuff (top) and the Upper Edmonton division from the Kneehills Tuff to the base of a continental (Paskapoo) sandstone overlying the upper coal seams which approximately coincides with the last occurrence of Triceratops. The Kneehills Tuff had been noted but not recognized as tuff until Sanderson's petrographic description in 1931. His statement: "....above a white or clayey sandstone 25 to 40 feet thick in a selenitic, chocolate-brown colored shale occurs the Kneehills Tuff", has caused confusion in some workers minds. Ritchie (1957) points out that locally several tuff beds may occur, always associated with a thin zone of dark shale varying in thickness from 10 to 15 feet "....and for this reason several dark shales are easily confused with the Kneehills Tuff zone. The absence of an underlying white zone serves to distinguish these shales from the true Kneehills association." This association of mauve shale carrying tuff beds and white bentonitic sandstone was used by Furnival (1946) to correlate the Battle and Whitemud Formations of the Cypress Hills in south-eastern Alberta with the Middle Edmonton division (see figure 6).

In the last decade many workers have attempted to define the lower boundary of the Edmonton Formation regionally.

Extensive summaries on this work were given by Ower and Elliot (1960) and Campbell (1962). (see figure 5 and 6) In contrast to these works based mainly on lithology, palynological studies of the Edmonton formation were undertaken by Srivastava (1965, 1968) and Snead (1968).

Srivastava found that "the appearance of new microflora and termination of many elements at different horizons allows recognition of nine microfloral assemblage zones and three subzones in 840 feet of strata of the Edmonton Formation in the Red Deer River Valley, Alberta". (see figure 5)

Since the Edmonton continental beds were laid down following the eastward retreat of the Bearpaw sea the microfloral assemblage zones should have considerable lateral extent and make it possible to correlate, with the type locality, small outcrops which lack distinctive megafossils and marker horizons.

Srivastava (1968) states that the microflora throughout the lower Edmonton Formation indicates a humid subtropical climate. This observation is supported by the occurrence of numerous coal seams in the area. Samples from the upper part of the coal beds at Sheerness yielded spores and pollen. Long ranging organ genera such as Gleichenites and Liliacidites are well represented.

According to Srivastava (1968) the lush subtropical flora reached its peak of expansion during the time the sediments of the Pulcheripollenites krempii Zone were laid down

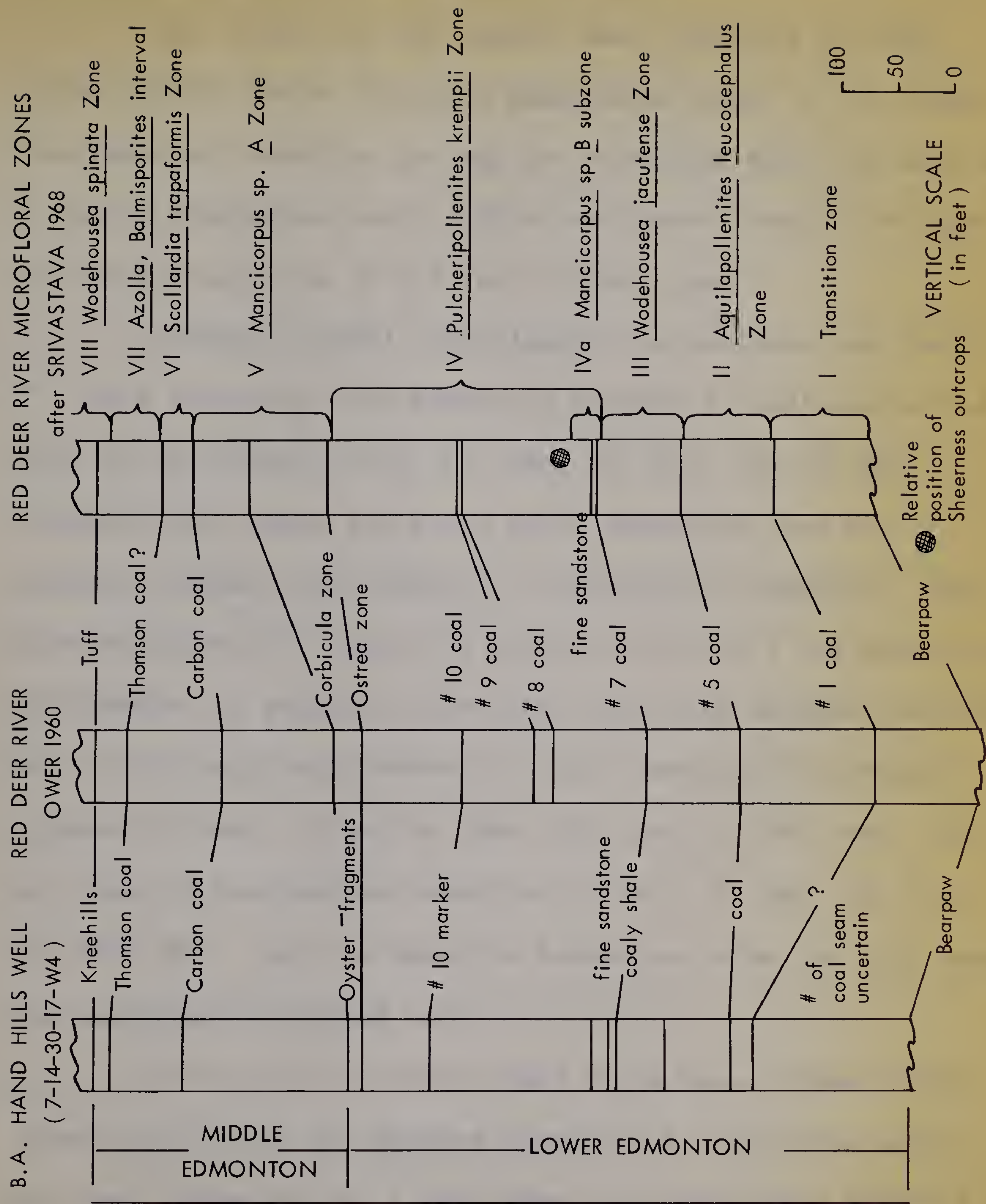


FIGURE 5. Correlation of selected stratigraphic markers of the Edmonton Formation between Drumheller and the Hand Hills, Alberta.

(see figure 5). The pollen assemblage found in the Sheerness badlands belongs to this zone.

Previous Work done in the Sheerness Area

The first mine was opened near Sheerness in 1910. Allan (1935) states "the coal seam being mined is the lowest in the Edmonton Formation and may be correlated with the seam No. 1 in the Drumheller basin. This coal seam rises to the east at the average rate of 3.4 feet to the mile."

Campbell (1962) investigated the badlands and found: "....the Kneehills Tuff Member is exposed in badlands on the side of the ridge in Sec. 22, Twp. 29, Rge. 13W 4th Mer., complete with mauve shale and white sandstone, and one or possibly several tuff layers." According to Campbell: "Near Sheerness (Twp. 29, Rges. 12 and 13, W4th Mer.) the Kneehills Tuff Member is separated from the underlying Bearpaw Formation by a thin lensy coal interval....the Kneehills Tuff Member exposed in Secs. 16 and 22. Twp. 29, Rge. 13, W4th Mer. lies so close to the Bearpaw Formation in Sec. 19, Twp. 29, Rge. 12, W4th Mer. that the Edmonton Formation below the Tuff member has essentially pinched out."

Working in the Castor-Hand Hills area, Lines (1963) placed the top of the Bearpaw Formation as occurring about 280 feet below the No. 1 coal seam. He definitely places a series of brown and grey banded shales within the Edmonton Formation which Campbell, (1962) tentatively referred to the underlying Bearpaw Formation.

Scope of the Thesis

This thesis represents an attempt to utilize Cretaceous angiosperm palynological data to determine the zonal position of a small outcrop sections far removed from the type locality and lacking conspicuous marker beds. More specifically the thesis is an attempt to correlate the beds of the Sheerness badlands with beds of the Edmonton Formation of the Drumheller area. For this purpose only the angiosperm pollen of diagnostic value and rare species are considered. Long ranging and indiscriminate forms have not been utilized in the discussion of correlation.

The number of pollen species utilized and figured in this correlation study include 32 species belonging to 17 organ genera. The species of angiosperm pollen involved in the correlation of the Sheerness badlands with the Edmonton Formation at Drumheller are listed below and illustrated in plates I-V.

AQUIFOLIACEAE

Ilexpollenites cf. *I. obscuricostata* (Traverse) Srivastava

BETULACEAE

Alnipollenites trina (Stanley) comb. nov.

BUXACEAE

Erdtmanipollis pachysandroides Krutzsch

CORIARIACEAE

Coriaripites alienus Srivastava

FAGACEAE

Quercoidites sternbergii Strivastava

HAMAMELIDACEAE

liquidambarpollenites sp.

LORANTHACEAE

Cranwellia striata (Couper) Srivastava

OLEACEAE

Fraxinoipollenites variabilis Stanley

PROTEACEAE

Beaupreaidites elegansiformis (Cookson) Srivastava

Proteacidites sp.

SIMAROUBACEAE

Ailanthipites cupidineus Srivastava

ANGIOSPERMAE INCERTAE SEDIS

Aquilapollenites amicus Srivastava

Aquilapollenites amplus Stanley

Aquilapollenites asper Mtchedlishvili

Aquilapollenites sp. *A*

Aquilapollenites sp. *B*

Aquilapollenites dispositus (Mtchedlishvili) Samoilovitch

Aquilapollenites dolium (Samoilovitch) Srivastava

Aquilapollenites minutus Srivastava

Aquilapollenites oblatus Srivastava

Aquilapollenites cf. *A. Procerus* Samoilovitch

Aquilapollenites sp. *C.*

Aquilapollenites cf. *A. validus* Srivastava

Aquilapollenites venustus Srivastava

Callistopollenites radiostriatus (Mtchedlishvili) Srivastava

Mancicorpus sp. *B.*

Mancicorpus senonicus Mtchedlishvili

Mancicorpus sp. A.

Mtchedlishvilia canadiana Srivastava

Mtchedlishvilia sp.

Orbiculapollis globosus (Chlonova) Chlonova

Pulcheripollenites krempii Srivastava

Unfigured palynomorphs include genera of the following families: Lycopodiaceae, Cyatheaceae, Gleicheniaceae, Osmundaceae, Schizaeaceae, Polypodiaceae, Cycadaceae, Taxodiaceae, Podocarpaceae, many other families of the angiosperms as well as many spores and pollen of uncertain affinity.

CHAPTER TWO

SAMPLING AND PROCESSING

Sheerness Badlands

Sheerness is a village in east-central Alberta, latitude 51°30' N; longitude 111°40' W. The Sheerness badlands are located about three miles due west of the railroad station at Sheerness which is on Lsd. 6, Sec. 19, Twp. 29, Rge. 12, W 4th Mer. (see figure 2). The outcrops are trending in a southwesterly direction and parallel a seasonal stream which drains into Coleman Lake. A road going from Sheerness to HWY. 36 skirts the northern end of the badlands (see figure 3).

Collecting

Samples for palynological analysis were collected from one exposure south of this road in Lsd. 13, Sec. 22, Twp. 29, Rge. 13, W 4th Mer. The section chosen covers a bedrock exposure of about 34 feet in vertical extent. The vertical distance from the highest sample taken to the lowest soil horizon is approximately 6 to 8 feet. The exposure is steep and shows no sign of slump movement. The samples were taken from about 2 feet in from the exposed face of the beds and sampling was from the bottom of the section to the top. This procedure was followed to avoid surface contamination. The sample position and the lithologic features in the section are shown in figure 6. The section consisted mainly of shale beds showing leaf compression fossils probably of gymnospermous affinity.

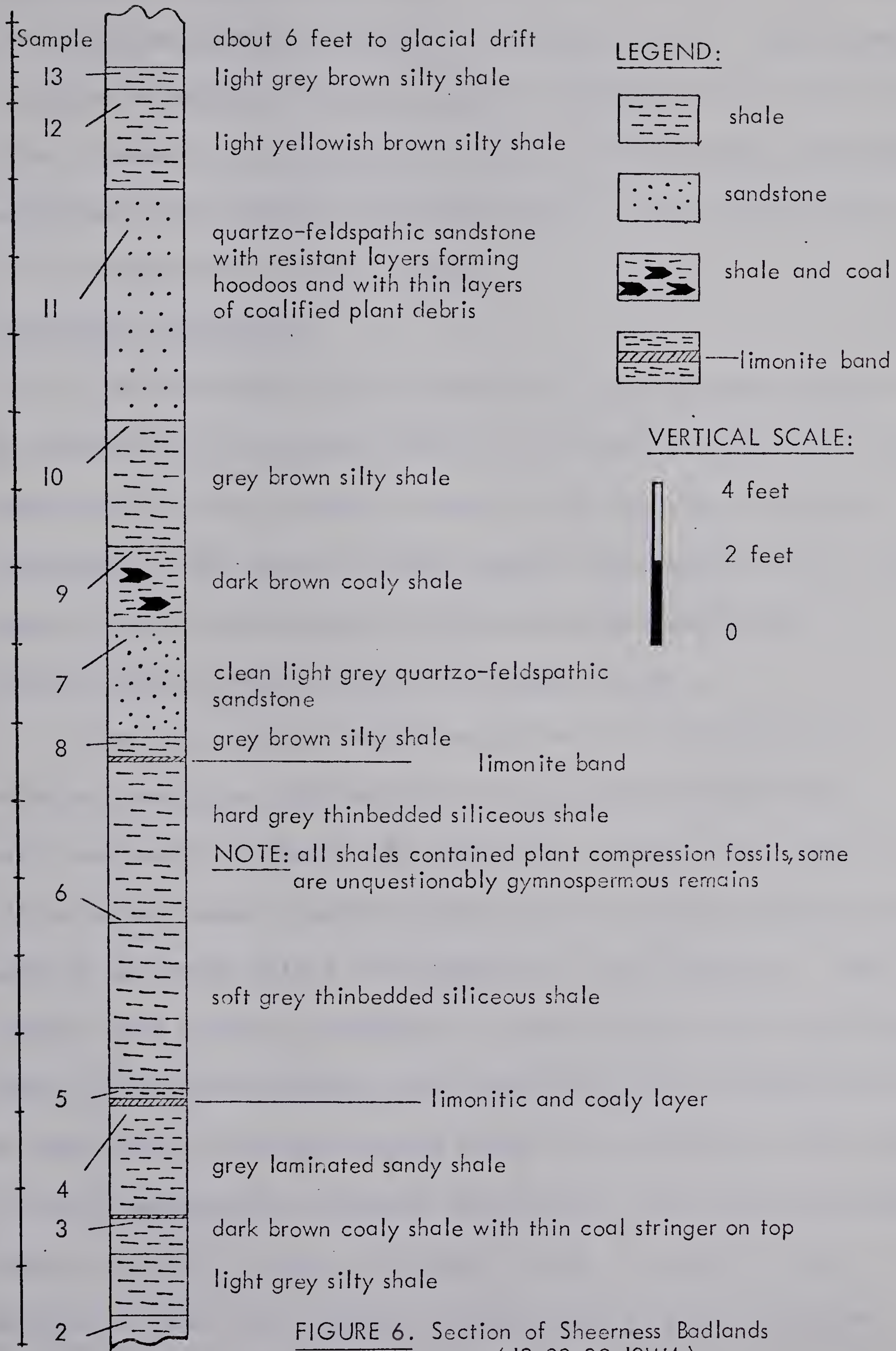


FIGURE 6. Section of Sheerness Badlands (13-22-29-13W4)

Thin coal stringers less than 4 cm. thick occur in the section. The sandstone layers are barren of fossil pollen. Each sample consists of pieces of shaly material gathered from no more than 3 to 4 inches of stratigraphic interval and as each sample was collected into numbered polythene bags no dust contamination is to be expected between samples.

Laboratory Processing

The procedure for treatment of palynological samples as outlined by Srivastava (1965, p. 30) was followed with the omission of several steps as none of the samples contained carbonates. The amount of each sample processed was 10 to 20 grams of shale broken down to pea-size and transferred to a plastic beaker labelled with the sample number.

As all samples tested negative for carbonates the chemical procedure started with concentrated hydrofluoric acid treatment to remove the silicates. Since the amount of silicate per sample varied significantly, periodic checks were made to see when silica disintegration was completed. Then the samples were washed thoroughly by centrifuging with distilled water. (This centrifuging with distilled water followed the end of each step in the processing before new chemicals were used to avoid undesirable chemical reactions.) Following this the sample was put through a 100 mesh screen to separate the megaspores from the smaller fractions which were processed

further.

The residue from above was treated with freshly prepared Schulz's solution to oxidize carbonaceous material. Periodic checks were made to see that no microfossils were being destroyed. The average time per sample was one half hour.

Superfluous organic debris was dissolved by suspending the sample in 10% potassium carbonate solution for about 10 to 15 minutes until the sample turned dark brown. The sample was then diluted with distilled water and washed thoroughly. Centrifuging the sample up to 20,000 rpm. removed most of the lighter organic material which had not been dissolved.

In a few samples, where the inorganic matrix could not be removed, the microspores were separated by a heavy liquid mixture of zinc iodide, potassium iodide and cadmium iodide. The specific gravity of the liquid was kept at 2.1. If this step was not needed, the slides were prepared directly from the residue. For a heavy liquid separation the samples were treated as follows:

(a) Sample was mixed with heavy liquid in a test-tube. The greater the dispersion of the material in the liquid, the better the separation.

(b) Sample was centrifuged for longer time at 30,000 rpm.

(c) Upper portion of liquid containing microspores lighter than 2.1 specific gravity was decanted into a plastic

beaker and diluted approximately five times with distilled water. The microspores, now heavier than the surrounding liquid, were left standing overnight to settle out.

(e) The upper portion of the sample was discarded after checking for microspores. The lower portion was centrifuged and repeatedly washed with distilled water. Gelatinous precipitates of iodides were removed by adding a few drops of dilute hydrochloric acid to the sample.

(f) The recovered material was stored in small glass vials under water mixed with Safranin O to stain the microspores.

Preparation of the Slides

A little phenol was added to cornsyrup to protect it from fungal or bacterial infection. The syrup was then diluted to a suitable viscosity so that when a drop of it was placed on a slide it would not flow out too swiftly, nor would it arrest any air bubbles.

1. Three drops of prepared cornsyrup were placed in the center of the slide.

2. A little organic residue containing the stained microspores was taken with the tip of a spatula from the storage vial and mixed thoroughly with the syrup before the mixture was spread to cover about two thirds of the slide using the spatula.

3. The remaining third was used to enter the sample and slide number.

4. 10 slides were prepared from each sample.

Recording of Pollen Data

Two to five slides for every sample were examined depending on the abundance of pollen grains in the sample. The first slide of each sample was scanned lengthwise along lines one millimeter apart and under x100 magnification recording all the different species once. Second and subsequent slides were scanned along lines 5 millimeters apart to estimate the relative frequency of occurence of different species, counting 10 or more specimens as abundant, 9-5 specimens as common and 4-1 specimens as rare.

Photomicrographs were taken by an Orthomat Leitz microscopic camera. Addox KB14 35 mm. film was used and the photographs were printed on Kodak Polycontrast F paper and AGFA Brovira BEHI paper. Wherever possible photographs were taken under oil immersion to show maximum detail.

All the figured specimens illustrated on the plates are at a magnification of x1000 to give the idea or relative size differences. A few figured specimens which exceed the normal size range are shown at a magnification x500 with details of morphology shown 1000x enlarged.

CHAPTER THREE

DISCUSSION AND CONCLUSIONS

Microflora recovered

The microfloral assemblage recovered from the Sheerness badland includes those listed on pages 10 and 11. The occurence of the more diagnostic angiosperm fossil pollen species found in the Sheerness section (see Table 1 below) may be compared with the occurrence of the same species in the Drumheller area found by Srivastava (see Figure 8). The recovery of fossil pollen was good.

Table 1.

Relative frequency of occurence of diagnostic angiosperm pollen species in the Sheerness badland section.

Section:	Bottom	Center	Top
Fossil Pollen			
Aquilapollenites			
amicus	common	rare	rare
amplus	common	common	common
asper	rare	common	abundant
A.	rare	rare	rare
B.	rare	abundant	common
dolium	common	rare	rare
minutus	rare	rare	abundant
oblatus	abundant	rare	rare
venustus	common	rare	rare
Beaupreaidites			
elegansiformis	rare	rare	common
Mtchedlishvilia			
canadiana	rare	rare	abundant
Pulcheripollenites			
krempii	rare	common	common

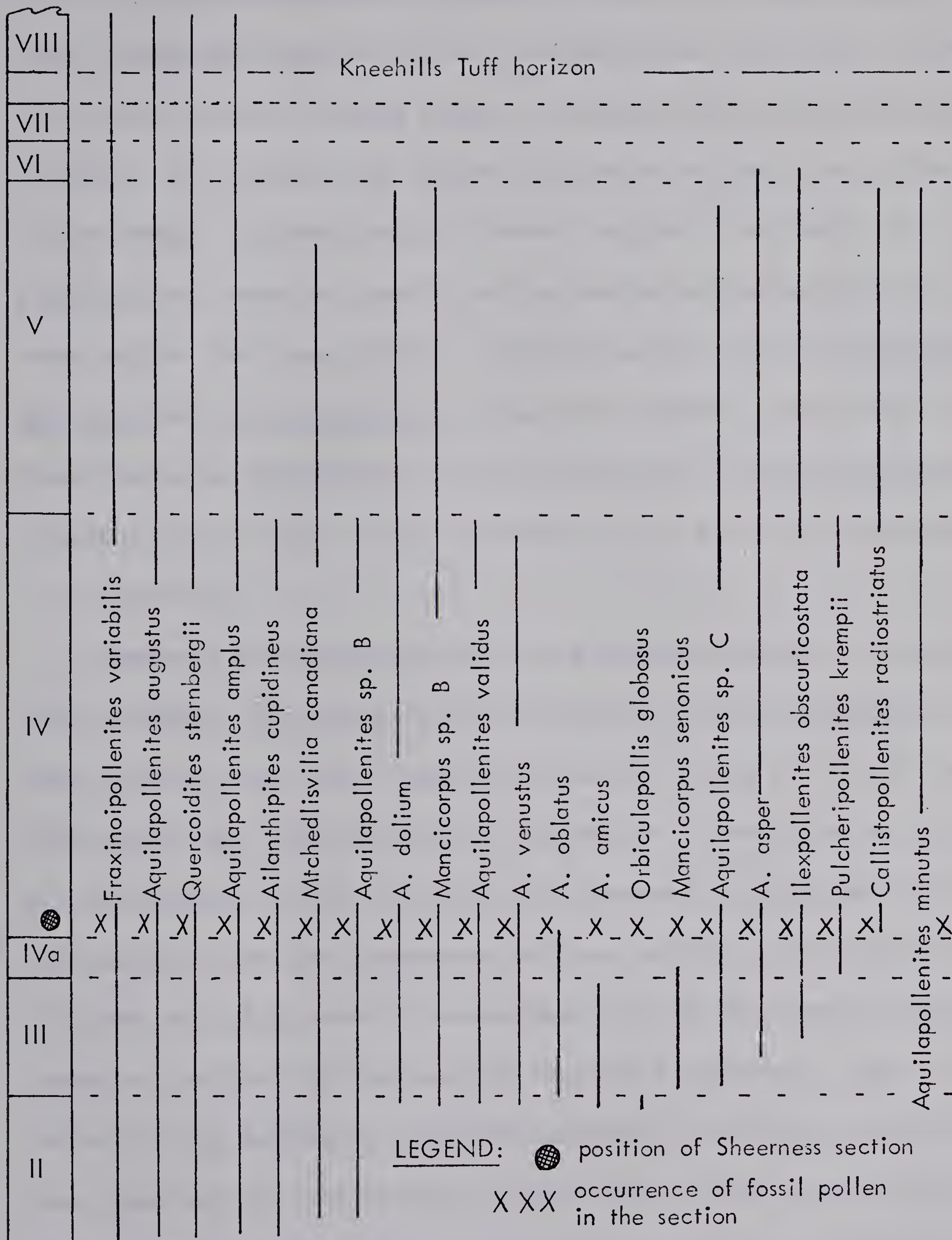


FIGURE 8. The occurrence of diagnostic angiosperm pollen and relative position of the Sheerness section in the Edmonton Formation, ranges and zones after Srivastava (1968).

On the other hand the variety in the microflora assemblage recovered from the top of the Sheerness coal seam is small. Many pollen grains showed signs of damage from the coalifying process. In general the higher the grade of coal the poorer the recovery. Spores usually show a higher resistance to physical and chemical agents of corrosion and decomposition than pollen (Havinga, 1967). Trilete spores of the Lycopodiumsporites and Gleicheniidites type were common. Among the dicotyledonous angiosperm pollen a species of Liliacidites was abundant while cycad and gymnosperm pollen were less frequent in occurrence.

There is no indication of any extensive change of assemblage between the Sheerness coal seam and the Sheerness badlands outcrop and both assemblages would indicate a fresh water environment for both horizons. No marine elements were found in the samples from the top of the Sheerness coal seam nor in the samples from the Sheerness badland section. Therefore both of these outcrops should be assigned to the freshwater Edmonton Formation and not to the marine Bearpaw Formation. There is no indication of marine or brackish elements at either level so the coal seam may be interpreted in this area to be above the lowermost transition zone of the Edmonton Formation (see Figure 5).

Studies of entemopholous pollen transport e.g. in the Rosaceae have shown that their distribution does not exceed a radius

of a few miles from the source area whereas anemopholous pollen such as <u>Podocarpites</u> may be blown 50 miles or more from the original source. Since the spores of Lycopods, ferns etc. germinate on almost any substrate they generally have a dispersion radius of less than 100 feet from the sporophyte. The abundance of entemopholous pollen and spores seems to support the idea of a freshwater environment close to the source area. All the shales of the section contain numerous plant compression fossils (e.g. <u>Sequoites</u> <u>sp</u>.), and are certainly not considered to be marine in origin (see Figure 4).

The fossil microflora found at Sheerness is quite sufficient to make a correlation with the microfloral zones outlined by Srivastava (1968). His microfloral zones of the lower and middle division of the Edmonton Formation along the Red Deer River are shown in Figure 5. This Sheerness suite is definitely lower Edmonton equivalent of Srivastava's <u>P</u>. <u>Krempii</u> Zone.

The section is only 34 feet in vertical extent without any lithological marker beds or diagnostic megafossils. The abundant leaf compression fossils found (e.g. <u>Sequoites</u> Sp.) indicate that no long range transportation took place. Thin stringers of coal between the shale beds may indicate that the plants were deposited very close to the original habitat.

The coal seam mined at Sheerness is quite thick (3 to 6.5 feet) and probably a good marker which can be traced with the

aid of mining and oilwell data to the Hand Hills and from there to the Drumheller type locality. There is no doubt that the No. 1 coal seam at Rosedale about 5 miles west of East Coulee was deposited in situ since large petrified tree stumps are found immediately beneath and in the coal. About 90% of these tree stumps and pieces of petrified wood found associated with them belong to the Taxodiaceae, (Ramanujam, 1968, pers. comm.). The genera *Taxodium*, *Glyptostrobus* and *Sequoia* are particularly well represented. The former two indicate a swampy environment. *Glyptostrobus* is not found in the recent flora of North America.

The palynological data obtained showed no apparent contamination of pollen from middle or upper Edmonton strata. However, forms like *Alnipollenites trina* and *Fraxinoipollenites variabilis* that had been recorded previously only from Paleocene and Lance (=Upper Edmonton) deposits respectively (Stanley 1965) would seem to have a longer stratigraphic range than formerly thought. The absence of other more abundant and more diagnostic pollen species described from the Upper Edmonton Formation and from Paleocene sediments in the Sheerness microflora supports this view. If contamination has occurred many other characteristic species should have been found, especially those which are far more abundant than either *Fraxinoipollenites* or *Alnipollenites* which Stanley cites as infrequent in occurrence in the sediments of Paleocene and Lance age from South Dakota.

All diagnostic species found occur throughout the Sheerness badland section. The relative frequency of occurrence indicates a decrease in Aquilapollenites amicus, A. dolium, and A. oblatus and an increase of Aquilapollenites asper. A. minutus and Mtchedlishvilia canadiana toward the top of the section (see Table 11).

Possible Sources of Error

The frequency of occurrence of a particular assemblage or single fossil pollen species is dependent on many factors. A few are mentioned here:

a) Laboratory technique: It is very difficult to achieve the same recovery from different samples using a standardized treatment. For instance, a shale reflecting highly anaerobic conditions and thus good preservation necessitates oxidation of the remaining plant material with Schulz's solution for a longer time than a shale laid down under more aerobic conditions where some oxidation has already taken place. Whereas a few grams of dark carbonaceous shale may yield an abundance of pollen, a pound of sandy shale may be needed to produce the same number of pollen grains. Thus one can use neither standard times for each step in the treatment nor can one use standard quantities of sample to be processed. Some samples need heavy liquid treatment to separate the lighter pollen from insoluble heavy minerals, i.e. minerals resistant to hydrochloric and hydrofluoric acid, while other samples rich in plant debris must be centrifuged at

different speeds to separate the heavier pollen from the lighter debris. The method used in the laboratory by the writer was aimed at the recovery of pollen from a variety of rock types in the best state of preservation possible. The data obtained thus do not lend themselves to a statistical treatment since there are no measurements of actual abundance available for the various samples processed.

b) Source material: Not only sandstone and shale beds may vary in pollen content and abundance but also two shales which are lithologically identical. This is due to paleo-environmental factors such as wind direction, amount of precipitation, soil conditions, etc. More pollen will be destroyed in areas where the chemical composition and pH of the water favour bacterial and fungal growth. Certain types of pollen especially those of the Pinaceae withstand auto-oxidation over a longer time while other pollens disintegrate within a few days or even hours after dispersal, e.g. pollen of *Populus tremuloides*. For detailed studies on this topic the reader is referred to Havinga (1967). Some sandy shales carrying significant amounts of groundwater may be leached and the removed pollen material may be concentrated on top of more impermeable beds. This causes not only a secondary enrichment of pollen but in many cases contamination that is hard to detect since the source bed may be very close to the enriched bed. Data obtained from such

horizons may influence paleo-ecological interpretations.

Taking all variable factors as discussed above into consideration the data obtained reflect the existence of a subtropic flora close to a freshwater depositional environment. The shift in relative frequency of certain species in this section may reflect seral changes rather than evolutionary changes.

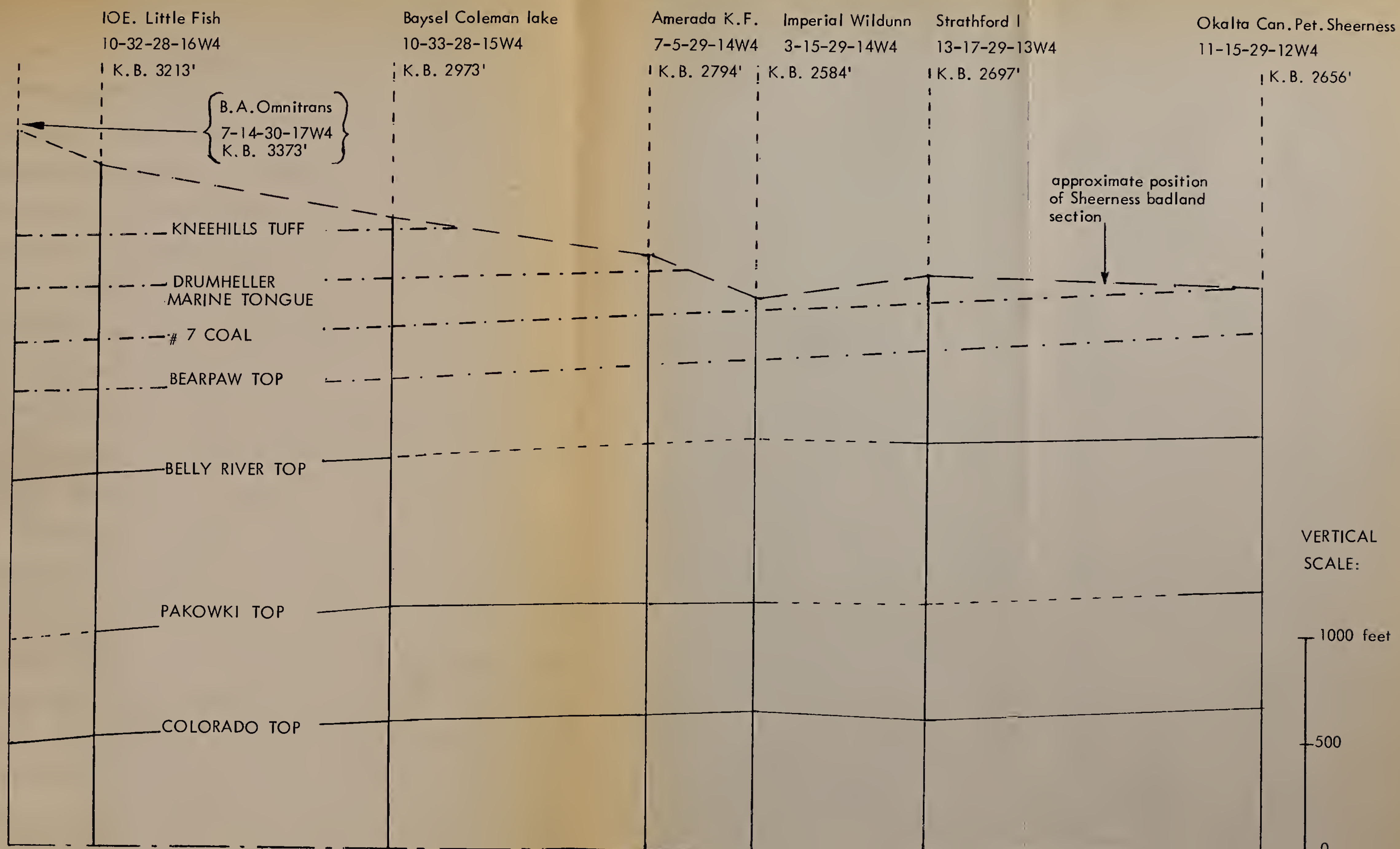
Geological considerations

All of the microfloral assemblage recovered from the Sheerness badland section falls into Srivastava's P. krempii Zone (see Figure 5 and 8).

Allan (1936) reports a variation in the dip of the Sheerness coal seam but the general trend is towards the north-west. A straight correlation between seam No. 7 at Drumheller and the strip mines at Sheerness would give a dip to the west of about 8 feet per mile. Allan's data show an average dip westward 3.4 feet to the mile in the Sheerness area. The coal seam is from 3 to 6.5 feet thick and seems to be continuous since mines have been operating in the past on both sides of Coleman Lake and the eastern slope of the Hand Hills. Thus the Sheerness badlands are underlain by the coal seam that is mined at Sheerness and the section begins about 45 feet above the seam, calculated by using Allan's dip measurement and points of known elevation in the area.

Palynological evidence from the top of the Sheerness coal seam places the seam above the transitional zone of the basalmost

FIGURE 7. Structural cross-section based on oilwell data and figures released by the Oil and Gas Conservation Board of Alberta.



Edmonton. However, no diagnostic index fossils have been found so far to confirm whether the Sheerness coal seam in fact is equivalent to the Drumheller No. 7 seam. If there is no stratigraphic break in the 45 feet between the Sheerness coal seam and the base of the Sheerness badland section this interpretation is logically sound since the coal seam is definitely above the transition zone between the Bearpaw and Edmonton Formation.

According to Ritchie (1957) the Kneehills Tuff of the type area occurs in the upper portion of 30 to 40 feet of dark brown bentonitic clay which in turn is underlain by 6 to 20 feet of white bentonitic sandstone. The succession of beds in the Sheerness section (see Figure 4) does not show such an association. "Kneehills Tuff is light brownish grey, massive, hard and extremely fine grained. It has a phonolitic ring when struck with a hammer, weathers to a light grey and forms surface talus of sharp angular fragments." (Ritchie, 1957). Layers of fine grained resistant sandstone occur throughout the Edmonton Formation and can easily be confused with tuff beds if the former occur in mauve shale. In this section, resistant layers forming small hoodoos were found only within a bed of light sandstone about 5 feet thick. No tuff fragments were found in the talus.

Close to the foothills the Kneehills Tuff is highly compressed and well indurated but it was never deeply buried out on the east-central plains nor subjected to folding and for this reason probably remained friable and susceptible to rapid

weathering (Burwash, 1968, pers. comm.). Therefore it is unlikely that large pieces of tuff would be preserved in the talus even if the Kneehills Tuff on top of the Sheerness badlands had recently been removed by erosion.

Oilwell data show that the Kneehills Tuff lies about 700 feet above the Bearpaw in the Hand Hills area (see Fig. 5 and 7). This would theoretically place the Kneehills Tuff about 500 feet above the present land surface at Sheerness. It seems unlikely that the lower Edmonton and most of the middle Edmonton i.e. 700 feet of sediments would thin to zero over a distance of about 25 miles between the Hand Hills and Sheerness. Oilwell data (see Fig. 7) indicate that at Coleman Lake, about 18 miles west of the Sheerness badlands, there are still the same 700 feet of lower and middle Edmonton present above the Bearpaw as found in the Drumheller area.

The Kneehills Tuff occurs high up on the eastern flanks of the Hand Hills and if the general dip of Edmonton beds is to the west the Kneehills Tuff should not be found 400-500 feet lower down 25 miles to the east of that locality without some topographic expression of easterly dips, faulting or signs of other mechanisms which could explain a possible occurrence of Kneehills Tuff in the upper part of the Sheerness badlands.

An oilwell 2 miles to the east of Sheerness records the top of the Belly River Formation underlying the Bearpaw Formation at a depth of slightly over 700 feet. This would give

the Bearpaw Formation a thickness of 700 feet if it did outcrop there at the surface. Allan (1936) states that along the Red Deer river the Bearpaw Formation is about 500 feet thick and he considers a maximum thickness of 700 feet as possible for this formation. In his paper Allan places the Bearpaw-Edmonton contact 2 miles to the east of Sheerness at an elevation of about 2600 feet above sea level. Lines (1963) gives a general thickness of 400 feet for the Bearpaw Formation for the Castor-Hand Hills area. He shows that Bearpaw and lower Edmonton beds are very similar in appearance and the one formation can easily be confused with the other. The similarities and transitions in lithology make it difficult to determine a boundary line between basal Edmonton and Bearpaw strata on the electrical logs from the oilwells since beds of similar lithology exhibit the same electrical properties.

In the absence of marine megafossils micropaleontological and palynological data are needed to place these beds correctly with respect to their stratigraphic position. Such data are not available at present from Campbell's (1962) proposed conformable Bearpaw-Edmonton contact at Sheerness.

Summary and conclusions

Palynological data permit correlation of the strata of the Sheerness badlands with strata of the middle Lower Edmonton at Drumheller about 300 feet above the top of the Bearpaw Formation or 800 feet above the top of the Belly River Formation.

At Sheerness the badlands strata are about 760 feet above the top of the Belly River Formation. Palynological data from the top of the Sheerness coal seam include no marine palynomorphs and the microflora is comparable to the one found by Srivastava from his upper East Coulee section and lower Drumheller section. This puts the Sheerness coal seam definitely above the basal Edmonton transition zone as defined by Srivastava (1968).

Consideration of the dip and strike of the coal seam in conjunction with oilwell data and its proximity to the Sheerness badland microflora identified as middle lower Edmonton indicates that the Sheerness coal seam probably is equivalent to the Drumheller No. 7 coal seam.

The Sheerness coal is not the equivalent of the Thomson coal which occurs about 30 feet below the Kneehills Tuff elsewhere since the Sheerness seam is overlain at the Sheerness badlands by middle lower Edmonton sediments.

There is no evidence of Kneehills Tuff either from talus or other erosional remnants, and the chocolate brown shale at the top of the Sheerness badland section is not upper Edmonton but middle lower Edmonton as shown by the pollen assemblage recovered from this horizon.

Electric log records and litholog data from oilwells in the area show no rapid thinning of lower and middle Edmonton beds and no rapid diachronic change seems to be taking place to substitute marine sediments of the Bearpaw Formation for

lower and middle Edmonton beds which are continental.

There is no evidence available to indicate that the Bearpaw Formation crops out at Sheerness.

The strata of the Sheerness badlands are all lower Edmonton, correlative with the strata comprising Srivastava's P. krempii Zone above coal seam No. 7 at Drumheller. Therefore Campbell's postulate that "The lower part of the Edmonton Formation (comprising Ower's Members A,B and C) is extremely wedge-shaped from west to east, allowing the Kneehills Tuff Member at Sheerness to rest on Bearpaw sediments that are probably younger than any in south-eastern Alberta," is found to be without supporting evidence.

CHAPTER FOUR

SYSTEMATIC DESCRIPTIONS

Only angiosperm microflora is treated in this chapter as the range calibration of the gymnosperm and spore elements has not been established as yet for the classic Red Deer section of the Edmonton Formation. Potonie's (1956, 1958, 1960) morphologic system of classification has been used in this study only at the generic and specific levels. Genera which could be associated with and/or assigned to natural families have been grouped under them as organ genera. Genera of uncertain affinity have been placed under Angiospermae-*incertae sedis*. For a discussion of the application of taxonomic principles in palynology see Singh (1964).

FAMILY AQUIFOLIACEAE

Genus *Ilexpollenites* Thiergart 1938

Type Species: *Ilexpollenites iliacus* (Potonie) Thiergart 1938.

Generic characters: Pollen grains of ovoid to spherical shape, equator trilobate to circular; pores noticeable; equatorial rugae present (tricolpate); exine shows closely spaced but free standing pila or clavae, these can be cudgel, mushroom or pear-shaped, sometimes even warty or rod-like; these elements increase in size towards the poles; exolamella is missing.

Ilexpollenites cf. I. obscuricostata (Traverse)

Srivastava 1966

Plate 1, Figure 1,2

cf. 1955 Ilexpollenites obscuricostata Traverse; Rept. Invest. U.S. Bur, Mines, 5151, p. 59, fig. 11 (75).

cf. 1966 Ilexpollenites obscuricostata (Traverse) Srivastava, Pollen et Spores, vol. 8, no. 3, p. 533, pl. 7, fig. 14

Description: Tricolpate pollen, spherical; colpi long, reaching poles; clavate, clavae short and closely spaced; furrow morphology not clearly visible.

Size Range: Equatorial and polar axis 24 microns.

Illustrated Specimen: Plate I, Fig. 1,2; (3A2), 30.2/127.

Locality: Sheerness badlands; lower division, Edmonton Formation; Maestrichtian. Lsd. 13, Sec. 22, Twp. 29, Rge. 13, W 4th Mer.

Note: All the following described specimens are from the same locality.

Remarks: Preservation often compresses pollen grains in which case they appear spherical instead of prolate. The specimens described by Traverse (1955) and Srivastava (1966) have much longer pila and are larger in size.

FAMILY BETULACEAE

Genus Alnipollenites Potonie 1932

Type Species: Alnipollenites verus (Potonie) Potonie 1934.

Generic characters: Pollen grains lentil shaped; pores 4 to 7, seldom 3, situated in the equatorial plane; amb triangular to polygonal depending on the number of pores; exine smooth or slightly scabrate, thickened in the region surrounding pores so that pores protrude markedly giving the grain an angular appearance; exolamellae more or less smoth; small vestibulum present.

Alnipollenites trina (Stanley) comb. nov.

Plate I, Figure 3,4

1965 Alnus trina Stanley, Bull. Amer. Paleont., vol. 49, no. 222, p. 289, pl. 43, figs. 4-6.

Description: Pollen grains tri/or tetraporate; amb triangular with concave sides or square with slightly convex sides; exine forms more or less concave arci connecting the pores; exine psilate, ornamentation infra-punctate; no evidence of a vestibulum present.

Size Range: 15.4 to 20.8 microns.

Illustrated Specimen: Plate I, fig. 3; (12A6) 52.6/115; fig. 4; (13/7) 46.4/120.9.

Locality: Same as above (see p. 32).

Remarks: Stanley (1965) describes this form from the Paleocene of South Dakota. Different species of Alnipollenites have been recorded from the Upper Cretaceous in Europe.

FAMILY BUXACEAE

Genus *Erdtmanipollis* Krutzsch 1962

Type Species: *Erdtmanipollis pachysandroides* Krutzsch 1962.

Generic characters: Polyporate spherical pollen grains with crotonoid-reticulate sculpture, intectate; small circular pores in the nexine, sexine baculate, baculae arranged in polygonal patterns around the pore margins; there seem to be pores only in 1/3 or the lumina formed.

Remarks: Srivastava (1968) notes that the baculae surrounding the pore margins form a somewhat funnel-like structure (crotonoid) which form a pseudo-reticulate pattern. Thus lumina formed between the pores are spaces formed by the radiating baculae.

Erdtmanipollis pachysandroides Krutzsch 1962

Plate I, Figure 5,6

1962 *Erdtmanipollis pachysandroides* Krutzsch, Geol., vol. 11, no. 3, p. 281, pl. 8, fig. 1-8.

Description: Pollen grains polyporate, pores generally less than 30 in number, pore rims bordered by baculae in polygonal patterns; amb circular to ovoid; sexine 2 to 2.5 microns thick, distinctly 2 layered, foot layer smooth, about 0.5 microns thick, baculae vary in length and thickness giving the pollen grain an irregular wavy outline, baculae arranged around pore margins, closer at the base, opening out like a funnel at their free ends; ornamentation crotonoid-reticulate.

Size Range: 22 to 26 microns.

Illustrated Specimen: Plate I, fig. 5, (13/5), 47.8/123.6

fig. 6, (13/5), 57.8/117.3

Locality: Same as above (see p. 32)

Remarks: Stanley (1965) created a new species *Pachysandra cretacea* which does not differ morphologically from *Erdtmanipollis pachysandroides* Krutzsch and *Pachysandra procumbentiformis* Samoilovich but rather seems to be a combination of both under a larger size range from 20 to 40 microns.

FAMILY CORIARIACEAE

Genus *Coriaripites* Srivastava 1968 (in press)

Type Species: *Coriaripites alienus* Srivastava 1968 (in press).

Generic characters: Tricolpate of tricolporate, pore and colpi breadth coincide in colporate conditions; colpi small, meridional, aspidate; poles flattened, polar axis compressed; amb broadly triangular with convex sides; sexine very thin; ornamentation obscure, slightly flecked or finely scabrate.

Coriaripites alienus Srivastava 1968

Plate I Figure 7

1968 *Coriaripites alienus* Srivastava (in press)

Description: Pollen grains tricolpate, colpi short, meridional, aspidate; amb subtriangular, sides convex with protruding colpi margins; sexine very thin, psilate.

Size Range: 25 microns.

Illustrated Specimen: Plate I, fig. 7, (13/5), 43/111.3

Locality: Same as above (see p. 24)

Remarks: This form has been described by Srivastava from the lower Edmonton Formation, Upper Cretaceous, Central Alberta.

FAMILY FAGACEAE

Genus *Quercoidites* Potonie, Thomson and Thiergart 1950

Generic characters: Equatorial view spindle shaped, conical towards the poles; colpi long reaching poles; exine infra-baculate.

Quercoidites sternbergii Srivastava 1966

Plate I, Figure 15

1966 *Quercoidites sternbergi* Srivastava; Pollen et Spores, vol. 8, no. 3, p. 529, pl. 7, figs. 22, 23.

Description: Tricolpate pollen grains; spherical in polar view and prolate in equatorial view; colpi long reaching the poles; exine tectate; sexine infra-baculate.

Size Range: Polar axis 21 to 25 microns, equatorial axis 15 to 17 microns.

Illustrated Specimen: Plate I, fig. 15, (13/5), 8.6/118.4

Locality: Same as above (see p. 32)

Remarks: Subprolate to prolate shape and smaller size of *Quercoidites sternbergii* distinguish it from other similar species. Srivastava (1966) records this species from the

lower Edmonton Formation at Drumheller.

FAMILY HAMAMELIDACEAE

Genus Liquidambarpollenites Raatz 1939

1953 Periporopollenites Pflug in Thomson and Pflug.

Type Species: Liquidambarpollenites stigmosus major Raatz 1937.

Generic characters: Pollen grains with 8 to 12 round to pit-like apertures, about 4 to 8 microns in diameter; amb spherical; exine finely spotted to finely reticulate.

Liquidambarpollenites sp.

Plate I, Figure 8

Description: Pollen grain with 12 to 15 rounded apertures; prolate; amb spherical; exine foveate; ornamentation psilate..

Size Range: Polar axis 24.8 microns, equatorial axis 21.0 microns, apertural diameters 2.1 to 2.7 microns.

Illustrated Specimen: Plate I, fig. 8; (13/5), 8.6/118.3

Locality: Same as above (see p.32)

Remarks: Several European authors have described a variety of different species of Liquidambarpollenites from the Middle Tertiary, no records from the Cretaceous are known.

FAMILY LORANTHACEAE

Genus Cranwellia Srivastava 1968 (in press)

1953 Elythranthe striata Couper; New Zealand Geol. Surv., Paleont. Bull. 22, p. 51, pl. 6, fig. 85

1966 Genus Cranwellia Srivastava; Pollen et Spores, vol. 8, no. 3, p. 537.

1968 Genus Cranwellia Srivastava emend Srivastava 1968; (in press)

Type Species: Cranwellia striata (Couper) Srivastava 1966

Generic characters: Isopolar; colpate or colporate pollen; apertures 3 or more, angulaperturate; pores conspicuous to inconspicuous; amb convex sides; colpi short or long, sometimes reaching the polar areas; poles flattened, polar axis compressed; equatorial angular projections well developed making pollen grain a three armed body; sexine tectate, granulate, granules arranged in linear striate pattern, in polar view striations starting from the middle of each mesocolpium and running across to the middle of adjacent mesocolpia, striations parallel to each other and perpendicular to the radius, from pole to apex of each equatorial angular projection.

Cranwellia striate (Couper) Srivastava 1966

Plate 1, Figure 9-11

1953 Elythrante striata Couper; New Zealand Geol. Surv. Paleont. Bull. 22, p. 51, pl. 6, fig. 85.

Description: Isopolar; tricolpate, colpi meridional, long reaching polar area, broad on the equatorial area; amb triangular; equatorial view ellipsoid; sexine tectate, granulate, on the polar caps granules appear at random, on the equatorial angular projections they form striations, striae circumambulate.

Size Range: 22 to 28 microns.

Illustrated Specimen: Plate I, fig. 9; (13/5), 54.1/111.8; fig. 10, (13/5), 54/120.5; fig. 11, (3A1), 54.4/122.1

Locality: Same as above (see p. 32)

FAMILY OLEACEAE

Genus Fraxinoipollenites Potonie 1960

1953 Tricolpopollenites, Thomson and Pflug, Paleontographica, col. 94. pt. B, p. 95.

Generic characters: Prolate tricolpate pollen grains; exine scabrate to reticulate, colpi long, distinct.

Fraxinoipollenites variabilis Stanley 1965

Plate I, Figure 12, 13.

1965 Fraxinoipollenites variabilis Stanley; Bull. Amer. Paleont. no. 222, p. 306, pl. 45, fig. 29-35.

Description: Prolate tricolpate pollen grains; amb spherical, equatorial view ellipsoid; colpi long, meridional, reaching polar area; sexine clavate; ornamentation finely reticulate.

Size Range: Polar axis 23 to 29 microns, equatorial axis 17 to 22 microns, length of clavae 1 to 1.5 microns.

Illustrated Secimen: Plate I, fig. 12; (13/5), 8.4/112.8; fig. 13, (13/5), 45.7/113

Locality: Same as above (see p. 32)

FAMILY PROTEACEAE

Genus Beaupreaidites Cookson emend Srivastava 1968

Type Species: Beaupreaidites elegansiformis Cookson 1950

Generic characters: Pollen grains with three colpoid apertures, angulaperturate, apertures vestibulate; amb triangular with blunt to round corners and straight sides; shape oblate; sexine fine to coarsely reticulate; retipilate to verrucate, thinner in apertural areas.

Beaupreaidites elegansiformis Cookson 1950

Plate I, Figure 19, 20; Plate II, Figure 1,2

1950 Beaupreaidites elegansiformis Cookson; Austral. Jour. Sci. Research, Ser. Biol. Sci., vol. 3, no. 2, p. 168, pl. 1, fig. 2-4.

1953 Beaupreaidites elegansiformis Cookson; in Couper; New Zealand Geol. Surv., Paleont. Bull. 22, p. 43, pl. 5, fig. 56.

Description: Triaperturate, angulaperturate, apertures colpoid, equatorial; colpi short meridional, restricted within apertural area; amb triangular, sides slightly convex, concave or straight; corners rounded; polar axis and equatorial axis of equal length

or polar axis slightly shorter; sexine thick, baculate, thinning considerably around the apertures; foot-layer separating and forming apertural zones; ornamentation finely reticulate, appearing striate around the apertural areas.

Size Range: Equatorial axis 35 to 47 microns, polar axis 32 to 42 microns, baculae 1 to 2 microns in height.

Illustrated Specimen: Plate I, fig. (12A6), 18.5/115; fig. 20, (13/7), 49.7/117.5; plate II, fig.1, (13/5), 50.3/114; fig. 2 (12A6), 11.4/118.2

Locality: Same as above (see p. 32)

Genus *Proteacidites* Cookson ex Couper 1953

Type Species: *Proteacidites adenanthoides* Cookson 1950.

Proteacidites sp.

Plate II, Figure 4

Description: Triaperturate; apertures large, colpoid; colpi meridional, extending beyond apertural zones; amb triangular, sides straight; poles flattened, polar axis compressed (oblate); sexine about 2.5 microns thick, no thinner apertural areas, tectate, outer layer capitate, middle layer baculate, foot-layer smooth; ornamentation in first focus on surface verrucate, in second focus coarsely reticulate, lumina 2 microns, muri 1 micron in diameter.

Size Range: 49 to 57 microns in equatorial diameter.

Illustrated Specimen: Plat II, fig. 4; (13/5), 9.2/110.7

Locality: Same as above (see p. 32)

Remarks: After *Beaupreaidites*: Specimens lying in the equatorial view may at first sight be confused with species of *Aquilapollenites*. e.g. *A. minutus*. Careful focusing reveals the thin apertural areas and the exine structure characteristic for *Beaupreaidites* species. The three equatorial projections are an optical illusion caused by the appearance of a straight line in the center, which is a focusing phenomenon.

FAMILY SIMAROUBACEAE

Genus *Ailanthipites* Wodehouse 1933

Type Species: *Ailanthipites berryi* Wodehouse 1933

Generic characters: Tricolporate, ellipsoidal or ovoid; amb subtriangular with slightly sunken angles; colpi long, reaching poles, small pores situated equatorially in colpi; sexine thin with fine infra-texture, surface almost psilate.

Ailanthipites cupidineus Srivastava 1968 (in press)

Plate I, Figure 14

1968 *Ailanthipites cupidineus* Srivastava (in press)

Description: Tricolporate, ellipsoidal, angulaperturate; colpi long, narrow, reaching poles, meridional; pores large, situated equatorially in the colpi; amb almost spherical; sexine

three-layered, foot-layer dense, baculate-layer light, tectate layer dense and scabrate; ornamentation infra-reticulate.

Size Range: Equatorial axis 16.8 microns.

Illustrated Specimen: Plate 1, fig. 14; (12A6), 11/127.8

Locality: Same as above (see page 32)

Remarks: Srivastava recorded this form from the lower Edmonton Formation below the Oysterbeds.

ANGIOSPERMAE INCERTAE SEDIS

Genus *Aquilapollenites* Rouse emend. Funkhouser restr. Srivastava

1957 *Aquilapollenites* Rouse; Can.Jour. Botany, Vol. 35 p. 370

1961 *Aquilapollenites* Rouse emend. Funkhouser; Micropaleontology, Vol. 7, no. 2, p. 193

1961 *Parviprojectus* Mtchedlishvilia in Samoilvitch an Mtchedlisvilia, Trudy Vses. Neft. Nauch., Issled. Geol., Razv. Inst., Leningrad.

1968 *Aquilapollenites* Rouse; emend. Funkhouser; restr. Srivastava (in press)

Type Species: *Aquilapollenites quadrilobus* Rouse 1957

Generic characters: Heteropolar or isopolar pollen with polar projections in which the reduced polar projection is at least half the length of the other polar projection. Pollen having the length of the reduced polar projection less than half the

length of the other polar projection are to be included in the genus. Mancicorpus Mtchedlishvili 1961, emend. Srivastava 1968. Three equatorial projections; tricolpate or tridemicolpate on each side of the equatorial projections; sometimes either in addition to or without meridional colpi, three equatorial projections; sometimes either in addition to or without meridional colpi, three equatorial colpi may be situated between or on the equatorial projections; ornamentation variable.

Aquilapollenites amicus Srivastava 1968 (in press)

Plate II, Figure 6, 7, 8.

1968 Aquilapollenites amicus Srivastava (in press)

Description: Pollen grains with three equatorially situated projections and with one projection each on the proximal and distal polar region; isopolar to subisopolar, poles rounded; equatorial projections small, round, auriculate to fan-shaped; tricolporate, colpi meridionally across the equatorial projections, long reaching polar area; pores elongate across the meridional colpi at the equatorial axis; exine pilate, sometimes baculate; ornamentation retipilate to finely reticulate, lumina less than 1 micron in diameter, exine very thin on equatorial projections.

Size Range: Polar axis 28 to 32 microns; equatorial axis 24 to 27 microns; distance from center of polar axis to the tip of equatorial projection 16 to 18 microns; breadth of equatorial projections variable, 7 to 12 microns.

Note: Length of equatorial projections will be given always as measured from the polar axis to the tip of the apex of the equatorial projection.

Illustrated Specimen: Plate II, fig. 6; (3A1), 33.2/121.9; fig. 7; (3A1), 47/127.6; fig. 8 (3A1), 18.9/119.6

Locality: Same as above (see p. 32)

Remarks: This form is abundant in the lower part of the Sheerness section and has been described by Srivastava from the lower Edmonton Formation at Drumheller.

Aquilapollenites amplus Stanley 1961

Plate III, Figure 4, 5, 6.

1961 Aquilapollenites amplus Stanley; Pollen et Spores, vol. 3, no. 2, p. 342, pl. 1, fig. 1-6; pl. 2, fig. 1-4; pl. 3, fig. 1-5

Description: Pollen grains with three equatorial and two polar projections isopolar; apices of all projections rounded, equatorial projections long, equal in width throughout, broadening at the base; tricolpate, colpi short, meridional across and restricted to apices of equatorial projections heavy staining probably supporting tissue extending from where colpi

end throughout the equatorial projections to their base; sexine tectate, baculate, with isolate spines in the apical polar regions, apices of equatorial projections densely covered with spinules, usually recurved towards the polar axis, rest of the body spineless; ornamentation infra-reticulate, reticulae smaller than 1 micron.

Size Range: Polar axis 40 to 46 microns, equatorial axis 15 to 19 microns, length of equatorial projections 27 to 30 microns, breadth of equatorial projections 12 to 14 microns.

Illustrated Specimen: Plate III, figure 4, 5, 6; (12A6), 27.5/113.

Locality: Same as above (see p. 32)

Remarks: First described from the Upper Cretaceous Hell Creek Formation, Maestrichtian by Stanley (1961). This species is abundant in the upper part but rare in the lower part of the Sheerness section.

Aquilapollenites asper Mtchedlishvili 1961

Plate IV, Figure 9, 10

1961 Aquilapollenites asper Mtchedlishvili in Samoilovitch and Mtchedlishvili; Trudy Vses. Neft. Nauch. Issled., Geol., Razv., Inst., Leningrad, vol. 177 p. 213, pl. 68, fig. 2 a-c.

Description: Pollen grains with tree equatorial and two polar projections, subisopolar; polar projections rounded; equatorial projections meridional, equal in length with the larger polar projections meridional, equal in length with the larger polar

projection, equal breadth throughout their length, widening slightly at the base and apices, apices rounded; tricolpate, colpi meridional, long, extending to the base of the equatorial projections; sexine tectate, baculate, covered with spinules 0.5 to 1 micron in length, smaller spinules concentrated on apices of equatorial projections larger spinules concentrated on apices of polar projections and thinly scattered over the pollen body, no spinules present on the central part of the equatorial projections; ornamentation infra-reticulate, reticulae about 0.5 microns across.

Size Range: Polar axis 46 to 49 microns, equatorial axis 18 to 21 microns, equatorial projections 22 to 25 microns.

Illustrated Specimen: Plate IV, fig. 9, 10; (13/7), 42.9/117.8

Locality: Same as above (see p. 32)

Aquilapollenites sp. A

Plate III, Figure 1, 2, 3.

Description: Pollen grains with three equatorial and two polar projections, isopolar, apices of all projections rounded; equatorial projections meridional, long, tricolpate, colpi short, meridionally across the apices of the equatorial projections, restricted within thinner apical regions; sexine tectate, baculate with spinules concentrated at the apical polar and equatorial regions, some large spines dispersed over the apices of polar projections; ornamentation infra-reticulate, reticula

about 1 micron in diameter.

Size Range: Polar axis 50 to 53 microns, equatorial axis 24 to 27 microns.

Illustrated Specimen: Plate III, Figure 1, 2; (12A6), 45.1/127.4; figure 3; (3A1) 57/120.6

Locality: Same as above (see p. 32)

Remarks: A specimen identical to the one shown on Plate III, Figure 1-3 has been described by Srivastava (1968) as *Aquilapollenites augustus* in his Ph. D. thesis, University of Alberta, Edmonton, p. 190, plate XV & XVI, fig. 3-6 & 1-4.

Aquilapollenites sp. B

Plate III, figure 8, 9.

Description: Pollen grains with three equatorial and two polar projections; isopolar to subisopolar; polar projections very small, conical; equatorial projections meridional, arising almost from the poles, width of base slightly shorter than polar axis, apices rounded; tricolpate, colpi meridionally across apices of equatorial projections, long; sexine tectate, intectate in part on equatorial projections, baculate, sexine thinning towards the apices of the equatorial projections; ornamentation infra-reticulate

Size Range: Polar axis 24 to 32 microns, equatorial axis 14 to 16 microns, equatorial projections 16 to 17 microns.

Illustrated Specimen: Plate III, fig. 8; (12A6), 52.3/130.5 fig. 9; (12A6), 29.4/130.3

Locality: Same as above (see p. 32)

Remarks: Srivastava (1968) reports this form as being confined to the lower Edmonton Formation under the name *Aquilapollenites decorus* in his Ph. D. thesis, University of Alberta, Edmonton; p. 211, plate XXIII, fig. 7-12.

Aquilapollenites dispositus (Mtchedlishvili) Samoilovitch 1967

Plate IV, Figure 7, 8

1961 *Triprojectus dispositus* Mtchedlishvili, Trudy Vses. Nauch. Issled., Geol. Inst., Leningrad, p. 205, pl. 65, fig. 1, 2.

1967 *Aquilapollenites dispositus* (Mtchedlishvili) Samoilovitch, Rev. Palaeobotan. Palynol., pl.2, fig. 8.

Description: Pollen grains with three equatorial and two polar projections, isopolar; polar projections rounded; equatorial projections long, apices conical; tricolpate, colpi short, meridionally across apices of equatorial projections; sexine tectate, baculate, spinules small, restricted to apical regions of equatorial and polar projections, recurved towards polar axis on equatorial projections; ornamentation infra-reticulate, very fine; lumina and muri of equal size about 0.5 microns in diameter.

Size Range: Polar axis 31 to 35 microns; equatorial axis 14 to 17 microns; length of equatorial projections 24 to 26 microns;

breadth of equatorial projections 9 to 11 microns.

Illustrated Specimen: Plate IV, fig. 7, 8, (12A6), 36.9/132.2.

Locality: Same as above (see p. 32)

Aquilapollenites dolium (Samoilovitch) Srivastava 1968 (in press)

Plate II, Figure 9.

1965 Parviprojectus dolium Samoilovitch, Trudy VNIGRI, vol. 239, pl. 3, fig. 1-3, 7-9.

1968 Aquilapollenites dolium (Samoilovitch) Srivastava (in press)

Description: Pollen grains with three equatorial and two polar projections, isopolar, polar projections not well developed, apices conical to rounded; equatorial projections very small, round in outline, equatorially flattened; tricolpate, colpi meridionally across the equatorial projections, long, narrow, reaching subpolar region; sexine pilate, pila small; ornamentation retipilate.

Size Range: Polar axis 25.5 microns, equatorial axis 27 microns, length of equatorial projections 18 microns, breadth of equatorial projections 6.8 microns.

Illustrated Specimen: Plate II, fig. 9, (3A1), 58.4/114.1

Locality: Same as above (see p. 32)

Aquilapollenites oblatus Srivastava 1968 (in press)

Plate IV, Figure 1, 2.

1968 Aquilapollenites oblatus Srivastava (in press)

Description: Pollen grains with three equatorial and two polar projections, isopolar; polar projections generally flattened; equatorial projections small, rounded semicircular to auriculate in outline; tricolpate, colpi meridionally across the equatorial projections, long, reaching polar area, sexine pilate, thick at the polar projections, thinner at the equatorial projections; ornamentation reticulate, lumina 0.5 to 1 micron across, muri 0.2 to 0.4 microns wide, on equatorial projections muri fanning out towards the margins giving a striate appearance.

Size Range: Polar axis 30 to 40 microns; equatorial axis 12 to 24 microns, length of equatorial projections 18 to 23 microns, their breadth 11 to 12 microns.

Illustrated Specimen: Plate IV, fig. 1, (3A1), 5/128.2; fig. 2. (3A1), 34.6/119

Locality: Same as above (see p. 32)

Remarks: This very conspicuous form has been recorded by Srivastava as being restricted to the lower Edmonton Formation at Drumheller.

Aquilapollenites cf. A. procerus Samoilovitch 1965

Plate IV, Figure 5.

cf. 1965 Aquilapollenites procerus Samoilovitch, Trudy Vses. Nauch. Issled., Geol. Inst., Leningrad, p. 126, pl. 11, fig. 163.

Description: Pollen grains with three equatorial and two polar projections, isopolar; equatorial projections perpendicular to the body, meridionally flattened, of equal width throughout, slightly shorter than the polar projections, apices rectangular; polar projections well rounded; tricolpate, colpi meridionally across equatorial projections, long, reaching base of polar apices; sexine of body and polar region pilate, equatorial projections baculate and thinner; ornamentation reticulate, lumina 0.7 to 1 micron, muri about 0.4 microns wide, muri flaring out to the margins of the equatorial projections giving them a striated appearance.

Size Range: Polar axis 26.4 to 34.4 microns, equatorial axis 11.2 to 12.4 microns, equatorial projections 12.8 to 13.6 microns.

Illustrated Specimen: Plate IV, fig. 5, (12A6), 25.3/130.6.

Locality: Same as above (see p. 32)

Remarks: Samoilovitch's form lacks reticulation at the polar apices, and has short colpi.

Aquilapollenites sp. *C*

Plate II, Figure 5

Description: Pollen grains with three quatorial and two polar projections isopolar; polar projections with rounded apices; amb triangular; equatorial projections meridional, very broad at the base, tapering to narrow apices tricolpate, colpi meridional across the apices of the equatorial projections, short, restricted to the apices; dark staining probably supporting tissue from end of colpi to the base of equatorial projections; sexine tectate, baculate thicker in the polar regions; ornamentation finely infra-reticulate, spinules concentrated at the apices of polar and equatorial projections.

Size Range: Polar axis indeterminate, equatorial axis 12.4 microns, equatorial projections 31.5 microns.

Illustrated Specimen: Plate II, fig. 5; (12A6), 49.4/126.4

Locality: Same as above (see p. 32)

Remarks: Srivastava (1968) reports a similar form under the name *Aquilapollenites regalis* in his Ph.D. thesis, University Alberta, Edmonton, p. 203, pl. XVIII, in his fig. 6, 7. Its range is given in fig. 8 of this thesis.

Aquilapollenites sp. D

Plate II, Figure 10, 11.

Description: Pollen grains with three equatorial and two polar projections, subisopolar, polar projections rounded; amb subtriangular, equatorial projections small, extending from an expanded circular equatorial region, apices meridionally flattened, rounded; tricolpate, colpi meridionally across the equatorial projections, long, extending to polar regions; sexine pilate, pila short and closely spaced; ornamentation retipilate.

Size Range: Polar axis 34.5 microns, equatorial axis 27.2 microns, equatorial projections 13.8 microns.

Illustrated Specimen: Plate II, fig. 10, 11; (3A1), 18.4/111.9

Remarks: This form occurs together with Aquilapollenites amicus, A. dolium and A. oblatus in the lower part of the section.

Aquilapollenites venustus Srivastava 1968 (in press)

Plate IV, Figure 3, 4.

1968 Aquilapollenites venustus Srivastava (in press).

Description: Pollen grains with three equatorial and two polar projections, isopolar, poles rounded; equatorial projections small, apices rounded; tricolpate, colpi meridionally across the equatorial projections, long extending to the polar regions; sexine pilate; ornamentation on body retipilate.

Size Range: Polar axis 28 to 33 microns, equatorial axis 27 to 31 micron, equatorial projections 15 to 17 microns in length.

Illustrated Specimen: Plate IV, figure 3, (3A2), 55.5/125.9; figure 4, (12A6) 10/122.2

Locality: same as above (see p. 32)

Aquilapollenites cf. A. validus Srivastava 1968 (in press)

Plate IV, Figure 6.

cf. 1968 Aquilapollenites validus Srivastava (in press).

Description: Pollen grains with three equatorial and two polar projections isopolar; polar projections conical; equatorial projections small and rounded, base slightly constricted; Tricolpate, colpi meridionally across equatorial projections, long, reaching polar areas; three equatorial colpi, short. restricted within equatorial projections; sexine pilate; ornamentation retipilate, coarse on the body and polar projections, fine on the equatorial projections.

Size Range: Polar axis 36 to 39 microns, equatorial axis 17 to 20 microns, length of equatorial projections 16.5 to 18 microns.

Illustrated Specimen: Plate IV, fig. 6; (3A1), 40/115.8

Genus Callistopollenites Srivastava 1968 (in press)

Type Species: Callistopollenites radiostriatus (Mtchedlishvili) Srivastava 1968 (in press).

1961 Tricolpites radiostriatus Mtchedlishvili in Samoilovitch and Mtchedlishvili, Trudy. Vses. Neft. Nauch.-Issled. Geol.-Taxv. Inst. Leningrad, vol. 177, p. 249, pl. 81, fig. la-g, 2a, b.

Generic characters: 1968 Callistopollenites: Tricolporate; colpi meridional, long or short; pores large, equatorial, apidate, oncate; amb almost circular; sexine thick, clavate; ornamentation striate, striae disperse radially from a few centres.

Callistopollenites radiostriatus (Mtchedlishvili) Srivastava 1968 (in press)

Plate II, Figure 3

Description: Tricolpate, spheroidal; colpi long, meridional, narrow, reaching poles; pores large, equatorial, aspidate; amb circular; sexine thick, clavate; ornamentation striate.

Size Range: Diameter 32 to 36 microns.

Illustrated Specimen: Plate II, figure 3; (12A6), 36.5/120.

Locality: Same as above (see p. 32)

Genus Mancicorpus Mtchedlishvili emend. Srivastava 1968 (in press)

1961 Mancicorpus anchoriforme Mtchedlishvili in Samoilovitch and Mtchedlishvili; Trudy. Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., Leningrad, vol. 177, p. 218.

Type Species: Mancicorpus anchoriforme Mtchedlishvili 1961

Generic characters: Pollen grains heteropolar; tricolpate; polar projection developed on one pole only, on the other side of the equatorial axis either polar projection is absent or developed into a small "tubercle", the length of the underdeveloped pole from the center of the equatorial axis to the tip of the pole is less than half the length of the developed polar projection from the center of the equatorial axis to the tip of that pole; body cylindrical with rounded ends, conial or truncated conical equatorial projections form a right or an obtuse angle at the junction with the body, or the angle may be absent and the line of junction may be slightly convex; equatorial projections long or short, broad or somewhat narrow, flattened in polar plane; colpi narrow, long, sometimes apparently curved, becoming wide at the ends, sometimes demicolpate; sexine baculate, tegilate, infra-reticulate, clavate or reticulate.

Mancicorpus *sp.* A

Plate V, Figure 12

Description: Pollen grains with three equatorial projections and one polar projection, pollen body at the other pole reduced producing a slight concavity; equatorial projections well developed, meridional, arising from both polar areas, apices pointing downward i.e. towards the undeveloped pole; apices broadly rounded; tricolpate, colpi long, meridionally across

the equatorial projections, very short transverse colpi crossing the meridional colpi on the apices of the equatorial projections; sexine tectate, pilate; ornamentation infra-reticulate, lumina generally less than 0.5 microns, muri 0.2 microns wide.

Size Range: Polar axis 26 to 28 microns, equatorial axis 13 to 15 microns length of equatorial projections measured from their apex to the polar axis 12 to 15 microns.

Illustrated Specimen: Plate V, fig. 12

Locality: Same as above (see p. 32)

Mancicorpus sp. B

Plate V, Figure 1, 2.

Description: Pollen grains with three very long equatorial projections, one polar projection developed the other very small; polar projection pyramidal with a pointed apex; equatorial projections meridional, bent towards the underdeveloped polar projection arising from polar region, extending into narrow projections with rounded apices ending in spines recurved towards the body; tricolpate, colpi short, meridionally across apices of equatorial projections; sexine bastionate on polar projections, ornamentation reticulate, sexine on equatorial projections tectate; ornamentation faintly infra-reticulate, reticulations large near the body becoming progressively smaller in size towards the apices of the equatorial projections.

Size Range: Polar axis 23 to 25 microns, length of equatorial projections from polar axis to tip of their apices 36 to 39 microns.

Illustrated Specimen: Plate V, fig. 1; (12A6), 24.5/123; fig. 2; (13/5), 4.8/127.

Remarks: The specimen described above is comparable with Manicorpus rostratus in Srivastava's Ph.D. thesis, University of Alberta, Edmonton; p. 239, plate XXXIV, fig. 1,2. which is larger in size and has tubular equatorial projections while the writer's specimens have distinctly flattened equatorial projections.

Mancicorpus senonicus Mtchedlishvili 1961

Plate V, Figure 10, 11.

1961 Mancicorpus senonicus Mtchedlishvili in Samoilovitch and Mtchedlishvili; Trudy. Vses. Neft. Nauch.- Issled. Geol.-Razv. Inst., Leningrad, vol. 177, p. 224, pl. 72, fig. 2 a-c, 3.

Description: Pollen grains with three equatorial projections and one well developed polar projection, the other absent or very small; equatorial projections meridional, apices rounded; tricolpate, colpi meridionally across equatorial projections extending to the poles, dark staining areas on both sides of equatorial projections where they meet the body, probably supporting tissue; equatorial projections and apex of polar projection tectate baculate intectate in some areas of the

body and polar projection; ornamentation finely infra-reticulate to granulate on the polar projection.

Size Range: Polar axis 22 to 27 microns, length of equatorial projection from tip of apex to polar axis 15 to 21 microns.

Illustrated Specimen: Plate V, fig. 10; (12A6), 14.9/121.4; fig. 11; (3A1), 28.6/126.4

Genus *Mtchedlishvilia* Srivastava 1968 (in press)

Type Species: *Mtchedlishvilia canadiana* Srivastava 1968 (in press)

Generic characters: Pollen grains with three well developed equatorial projections and without any polar projections; polar axis considerably compressed compared to equatorial axis; tricolpate, colpi meridional, long or short, across the equatorial projections; sexine thin; ornamentation variable.

Mtchedlishvilia canadiana Srivastava 1968

Plate V, Figure 5, 7, 8, 9.

1968 *Mtchedlishvilia canadiana* Srivastava (in press)

Description: Pollen grains with three equatorial and without polar projections; amb triangular; equatorial projections intersect polar axis all in one point by means of an exinous ridge running from the apices of the projections to the polar axis, apices sharply pointed; Tricolpate colpi meridional across the apices of the projections, short, restricted to apical area; sexine tectate, baculate; ornamentation finely

infra-reticulate.

Size Range: Equatorial axis 35 to 45 microns.

Illustrated Specimen: Plate V, fig. 3; (13/5), 50.5/124.4; fig. 4; (12A6), 21.3/120.2; fig. 6; (13/5), 22.6/128.

Remarks: This form differs from *Mtchedlishvilia canadiana* by its lack of spines and its triangular shape.

Genus *Orbiculapollis* Chlonova 1961

1957 *Triporina globosa* Chlonova, Tsv. Vost. Phil., AN-CCCP no. 2, p. 45, pl. 1, fig. 7.

Type Species: *Orbiculapollis globosus* (Chlonova) Chlonova 1961

Generic characters: Pollen grains round, with 4 regions strongly projecting above the general surface of the grains, covered by pore membraines, unlike with other similar morphologic types the apertures are weakly or not at all pronounced, 3 to 4 pores, pore opening quadratic, exine thin 1-1.5u, diameter from 18 - 85.5 u.

Orbiculapollis cf. *O. globosus* (Chlonova) Chlonova 1961

Plate I, Figure 16.

cf. 1961 *Orbiculapollis globosus* (Chlonova) Chlonova, Trudy. Inst. Geol., vol. 7, p. 88, pl. 15, fig. 115.

Description: Triporocolpoidate pollen grain, spherical, angulaperturate; colpi meridional, very small, situated at distal ends

of small equatorial projections; pores equatorial, in center of colpi, small, circular; amb circular; sexine tectate, about 1 micron thick, psilate.

Size Range: 19 t 24 microns in diameter

Illustrated Specimen: Plate I, Fig. 16; (12A6), 53/130.

Genus Pulcheripollenites Srivastava 1968 (in press)

Type Species: Pulcheripollenites narcissus Srivastava 1968 (in press).

Generic characters: Tricolpate, angulaperturate, oblate, colpi very short (brevicolpate) meridional, restricted within thickened angular areas; amb triangular with rounded angles, sides straight to slightly convex; sexine thick, tectate striate, circumambient to the angles in polar view.

Pulcheripollenites krempii Srivastava 1968 (in press)

Plate I, Figure 17, 18.

1968 Pulcheripollenites krempii Srivastava (in press)

Description: Tricolpate, angulaperturate, oblate, colpi short, meridional, restricted within thickened zones on angles of amb; amb triangular with rounded angles; sides convex; sexine, tectate, baculate, thick 1.5 to 2 microns, being thinner at center of the sides and thicker around the colpi; ornamentation irregularly striate, at polar areas striations meet and form pseudo-reticulate pattern.

Size Range: 30 to 35 microns.

Illustrated Specimen: Plate 1, fig. 17; (12A6), 18.8/120; fig. 18; (12A6), 8.2/117.8.

Remarks: This form has been used by Srivastava to designate a faunal assemblage between coal seam No. 7 and the Lower Oyster beds at Drumheller.

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PLATE I

Edmonton Formation, Sheerness, Alberta

Fig. 1,2		Ilexpollenites cf. I. obscuricostata (Traverse) Srivastava sample 3, slide 3A2, co-ord. 30.2/127
Fig. 3,4		Alnipollenites trina (Stanley) comb. nov. sample 12, slide 12A6, co-ord. 52.6/115 sample 13, slide 13/7, co-ord. 46.4/120.9
Fig. 5,6		Erdtmanipollis pachysandroides Krutzsch sample 13, slide 13/5, co-ord. 47.8/123.6 and 57.8/117.3
Fig. 7		Coriaripites alienus Srivastava sample 13, slide 13/5, co-ord. 43/111.3
Fig. 8		Liquidambarpollenites sp. sample 13, slide 13/5, co-ord. 8.6/118.3
Fig. 9-11		Cranwellia striata (Couper) Srivastava
	9,10	sample 13, slide 13/5, co-ord. 54.1/111 & 54/120
	11	sample 3, slide 3A1, co-ord. 54.4/122/1
Fig. 12,13		Fraxinoipollenites variabilis Stanley sample 13, slide 13/5, co-ord. 8.4/112.8 & 45.7/113
Fig. 14		Ailanthipites cupidineus Srivastava sample 12, slide 12A6, co-ord. 11/127.8
Fig. 15		Quercoidites sternbergii Srivastava sample 13, slide 13/5, co-ord. 8.6/118.4
Fig. 16		Orbiculapollis cf. O. globosus (Chlonova) Chlonova sample 12, slide 12A6, co-ord. 53/130
Fig. 17,18		Pulcheripollenites krempii Srivastava sample 12, slide 12A6, co-ord. 18.8/120 & 8.2/117.8
Fig. 19,20		Beaupreaidites elegansiformis Cookson
	19	sample 12, slide 12A6, co-ord. 18.5/115
	20	sample 13, slide 13/7, co-ord. 7/117.5

NOTE: All specimens are illustrated at a magnification x 1000.

Plate I

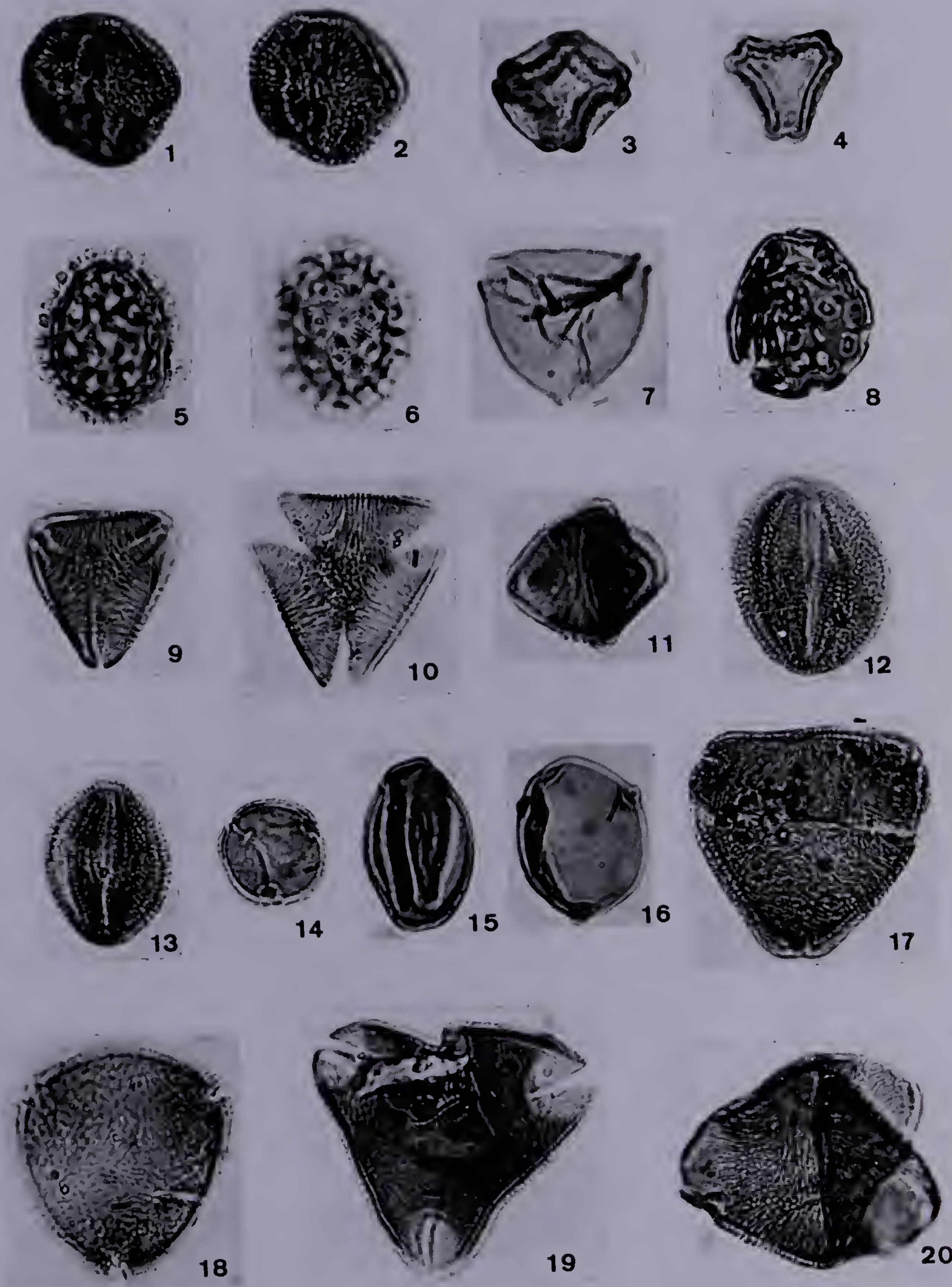

PLATE II

Edmonton Formation, Sheerness, Alberta

Fig.	1,2	Beaupreaidites elegansiformis Cookson
	1	sample 13, slide 13/5, co-ord. 50.3/114
	2	sample 12, slide 12A6, co-ord. 11.4/118.2
Fig.	3	Callistopollenites radiostriatus (Mtchedlishvili) Srivastava
		sample 12, slide 12A6, co-ord. 36.5/120
Fig.	4	Proteacidites sp.
		sample 13, slide 13/5, co-ord. 9.2/110.7
Fig.	5	Aquilapollenites sp. C.
		sample 12, slide 12A6, co-ord. 49.4/126.4
Fig.	6-8	Aquilapollenites amicus Srivastava
		sample 3, slide 3A1, co-ord. 33.2/121.9, 47/127.6 and 18.9/119.6
Fig.	9	Aquilapollenites dolium (Samoilovitch) Srivastava
		sample 3, slide 3A1, co-ord 58.4/114.1
Fig.	10,11	Aquilapollenites sp. D.
		sample 3, slide 3A1, co-ord. 18.4/111.9

NOTE: All specimens are illustrated at a magnification of x 1000.

Plate II

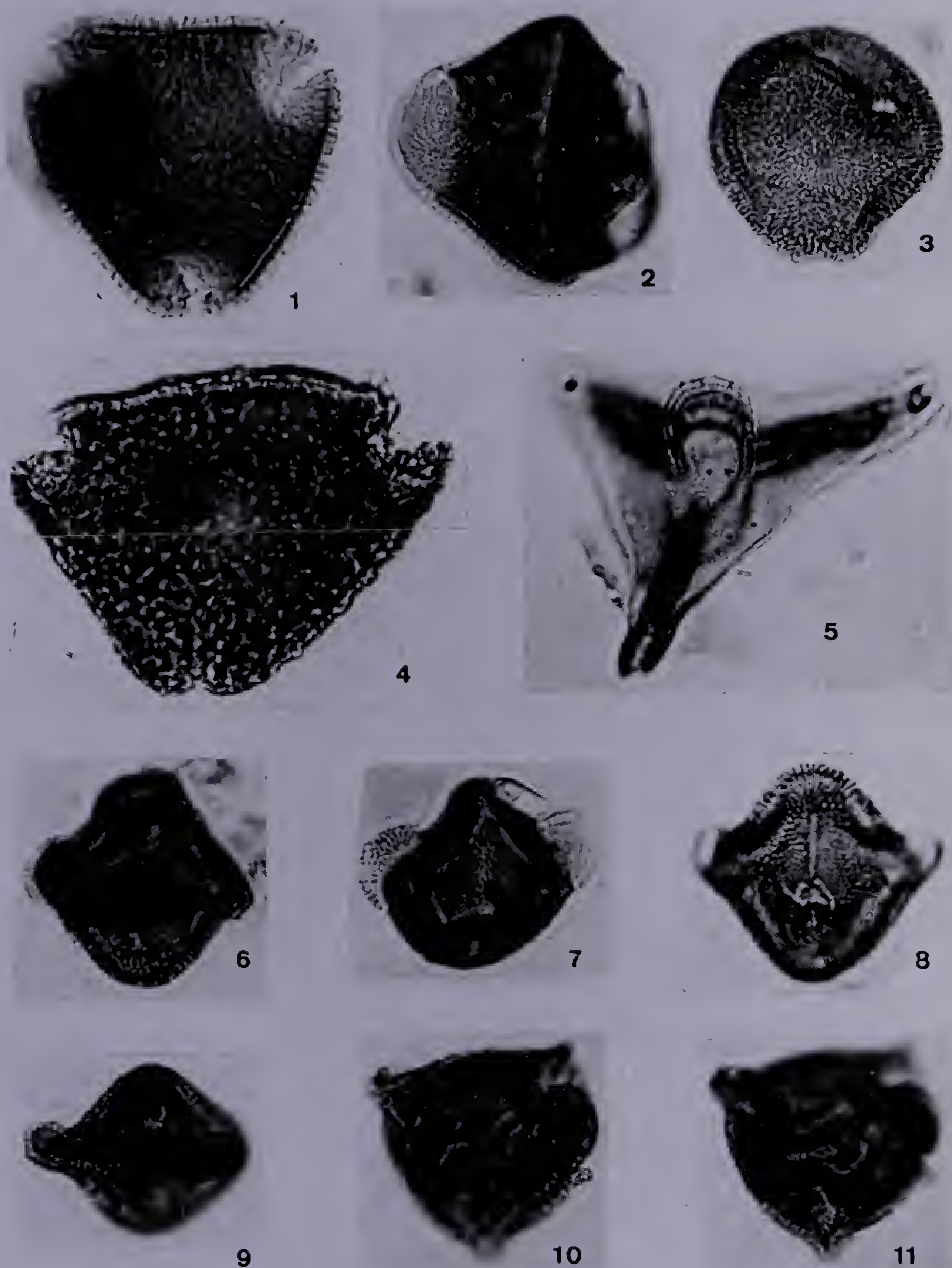

PLATE III

Edmonton Formation, Sheerness, Alberta

Fig.	1,2,3	Aquilapollenites sp. A.
	1,2	sample 12, slide 12A6, co-ord. 45.1/127.4
	3	sample 3, slide 3A1, co-ord. 57/120.6
Fig.	4-6	Aquilapollenites amplus Stanley sample 12, slide 12A6, co-ord. 27.5/113
Fig.	7	Aquilapollenites minutus Srivastava sample 12, slide 12A6, co-ord. 30.2/131
Fig.	8,9	Aquilapollenites sp. B. sample 12, slide 12A6, co-ord. 52.3/130.5 and 29.4/130.3

NOTE: All specimens are illustrated at a magnification of x 1000.

Plate III

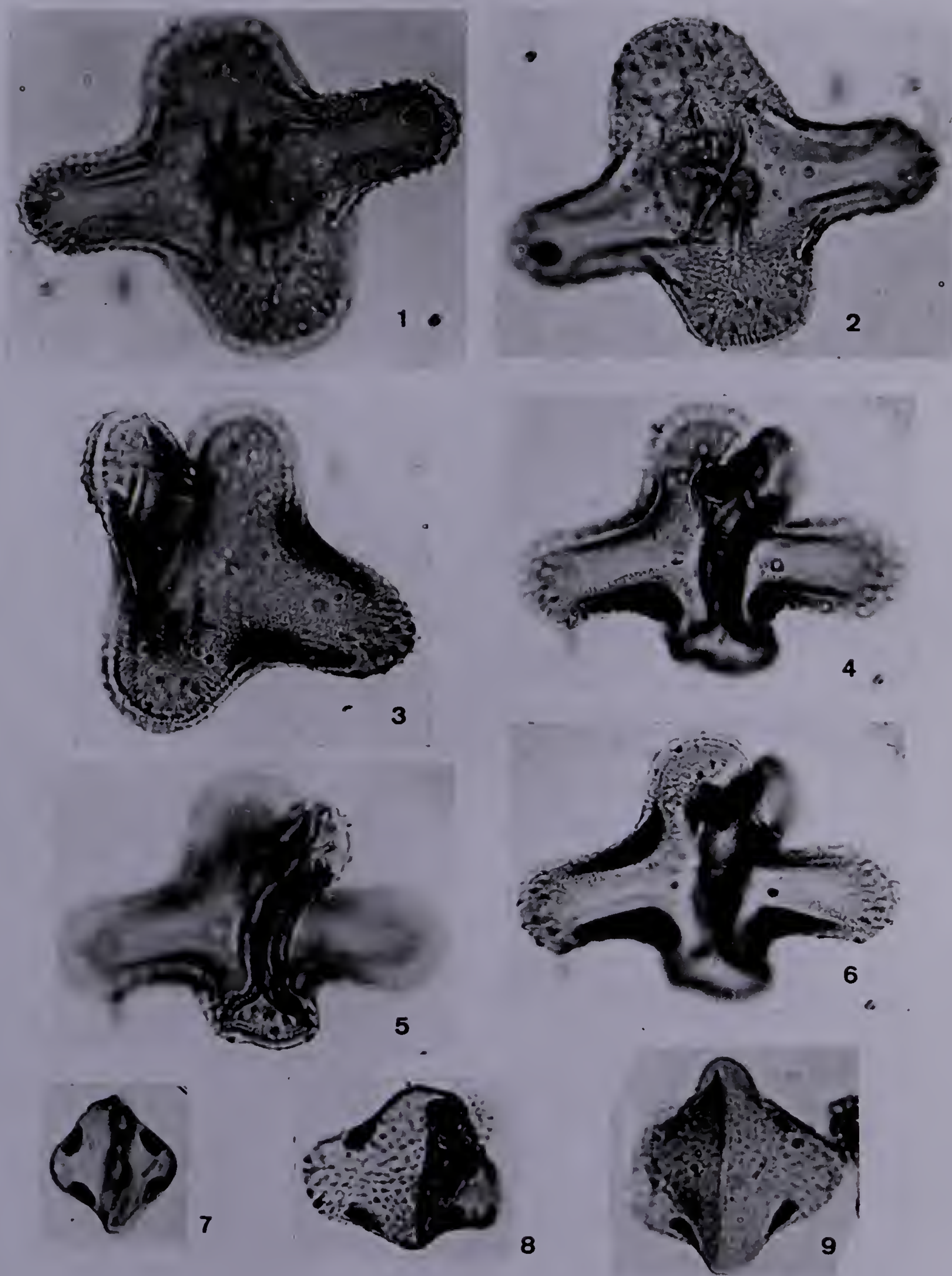

PLATE IV

Edmonton Formation, Sheerness, Alberta

Fig. 1,2	Aquilapollenites cf. A. oblatus Srivastava sample 3, slide 3A1, co-ord. 5/128 and 34.6/119
Fig. 3,4	Aquilapollenites venustus Srivastava
3:	sample 3, slide 3A2, co-ord. 55.5/125.9
4:	sample 12, slide 12A6, co-ord. 10/122.2
Fig. 5	Aquilapollenites cf. A. procerus Samoilovitch sample 3, slide 12A6, co-ord. 25.3/130.6
Fig. 6	Aquilapollenites cf. A. validus Srivastava sample 3, slide 3A1, co-ord. 40/115.8
Fig. 7,8	Aquilapollenites dispositus (Mtchedlishvili & Samoilovitch) in Samoilovitch and Mtchedlishvili sample 12, slide 12A6, co-ord. 36.9/132.2
Fig. 9,10	Aquilapollenites asper Mtchedlishvili in Samoilovitch and Mtchedlishvili sample 13, slide 13/7, co-ord. 42.9/117.8

NOTE: All specimens are illustrated at a magnification of x 1000.

Plate IV

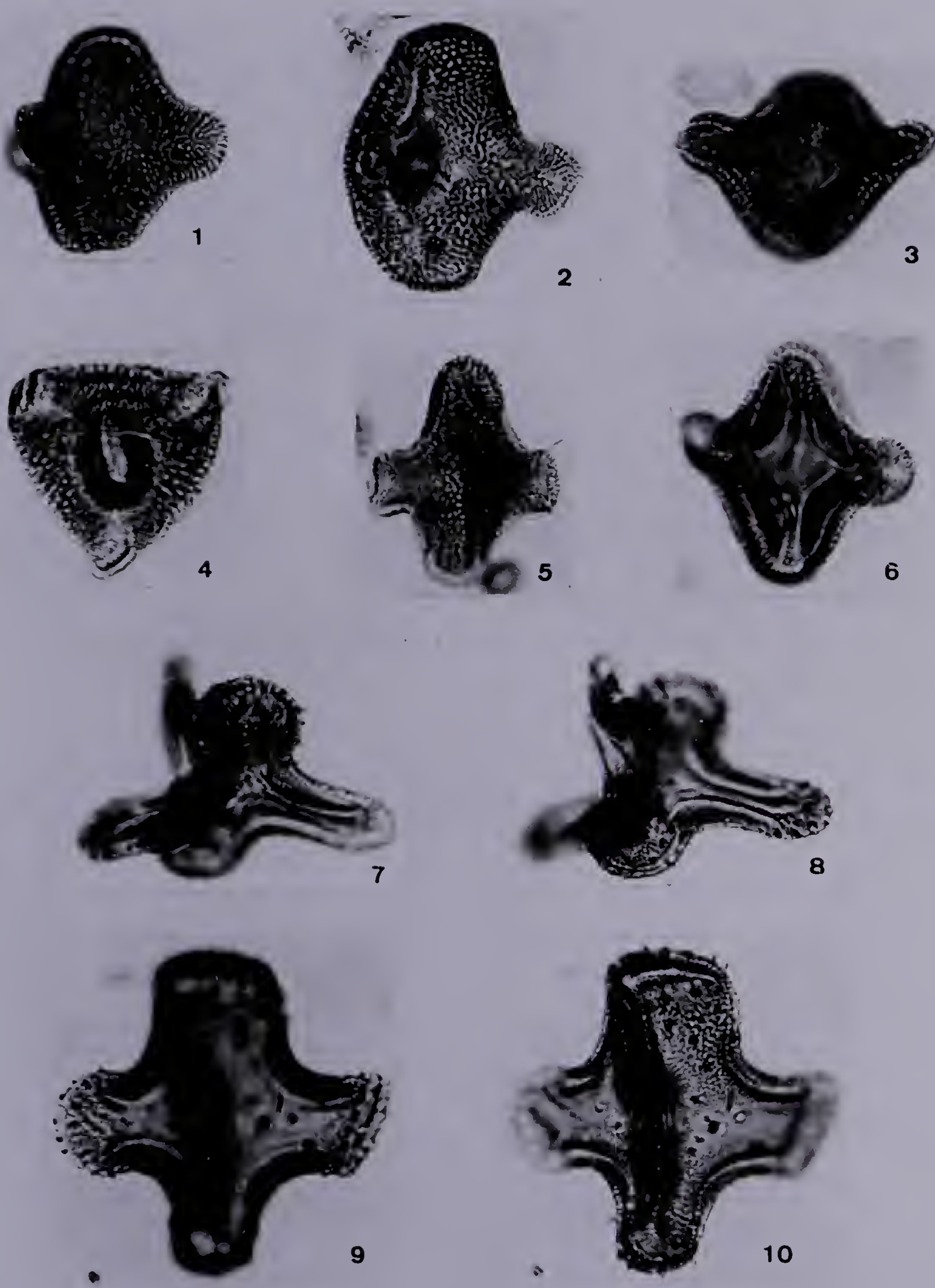

PLATE V

Edmonton Formation, Sheerness, Alberta

Fig. 1,2		Mancicorpus sp. B.
	1:	sample 12, slide 12A6, co-ord 24.5/123
	2:	sample 13, slide 13/5, co-ord, 4.8/127
Fig. 3,4,6		Mtchedlishvilia sp.
	3,6:	sample 13, slide 13/5, co-ord. 50.5/124.4 & 22.6/128
	4:	sample 12, slide 12A6, co-ord. 21.3/120.2
Fig. 5,7-9		Mtchedlishvilia canadiana Srivastava sample 13, slide 13/5, co-ord. 54.3/127.9; 41.6/124.5; 48.2/127.8
Fig. 10,11		Mancicorpus senonicus Mtchedlishvili in Samoilovitch and Mtchedlishvili
	10:	sample 12, slide 12A6, co-ord. 14.9/121.4
	11:	sample 3, slide 3A1, 28.6/126.4
Fig. 12		Mancicorpus sp. A. sample 13, slide 13/7, co-ord. 27.3/114.6

NOTE: Specimens in Fig. 7,8,9 are illustrated at a magnification of x 500, all other illustrated specimens are magnified 1000 x.

Plate V

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